

**DOCUMENTATION FOR THE 1996 BASE YEAR NATIONAL TOXICS  
INVENTORY FOR COMMERCIAL MARINE VESSEL AND  
LOCOMOTIVE MOBILE SOURCES**

**Prepared by:**

**Eastern Research Group, Inc.  
1600 Perimeter Park Drive  
Morrisville, North Carolina 27560**

**Distributed by:**

**Emission Factor and Inventory Group (MD-14)  
Emissions, Monitoring and Analysis Division  
U.S. Environmental Protection Agency  
Research Triangle Park, North Carolina 27711**

**June 2, 2000**



## TABLE OF CONTENTS

<b>Section</b>		<b>Page</b>
1.0	INTRODUCTION .....	1-1
1.1	What Is the National Toxics Inventory? .....	1-1
1.2	Why Did the EPA Create the NTI? .....	1-1
1.3	How Is the EPA Going To Use This Version of the NTI? .....	1-1
1.4	Report Organization .....	1-2
2.0	DEVELOPMENT OF THE NTI CMV AND LOCOMOTIVE MOBILE SOURCES	2-1
2.1	What Are CMV and Locomotive Mobile Sources? .....	2-1
2.2	How Were the CMV and Locomotive Emissions Estimated? .....	2-2
2.3	What Pollutants Are Included? .....	2-4
2.4	What Are the Results? .....	2-6
2.5	How Were National Emissions Allocated to Individual Counties? .....	2-6
3.0	WHAT ARE THE LIMITATIONS OF THIS CMV AND LOCOMOTIVE INVENTORY? .....	3-1
4.0	COMPILING THE INVENTORY DATA INTO THE NTI DATABASE .....	4-1
5.0	REFERENCES .....	5-1
Appendix A	1996 CMV Emission Estimates .....	A-1
Appendix B	1996 Locomotive Emission Estimates .....	B-1
Appendix C	Selected References for CMV Estimates .....	C-1

## **TABLES**

<b>Table</b>	<b>Page</b>
2-1      Summary of National 1996 CMV Emissions . . . . .	2-7
2-2      Summary of National 1996 Locomotive Emissions . . . . .	2-8
4-1      Data Fields in Mobile Source NTI . . . . .	4-1

## **1.0 INTRODUCTION**

### **1.1 What Is the National Toxics Inventory?**

The National Toxics Inventory (NTI) is a national repository of inventory data and estimated emissions for hazardous air pollutants (HAPs) and their sources. It was created by the Emission Factor and Inventory Group (EFIG) of the U.S. Environmental Protection Agency (EPA) in Research Triangle Park, North Carolina. The original version of the NTI has a 1993 base year, and it will be used as the baseline to track changes in HAP emissions nationwide. The 1996 base year NTI will provide support for air quality modelers and other risk assessment specialists. This report presents an overview of how the commercial marine vessel (CMV) and locomotive mobile source components of the 1996 NTI were compiled.

### **1.2 Why Did the EPA Create the NTI?**

The Clean Air Act (CAA), as amended in 1990, includes many HAP-related mandates for the EPA. The CAA presents a list of 188 HAPs (see <http://www.epa.gov/ttn/uatw/188polls.txt> for a list of pollutants and their commercial abstract service [CAS] numbers), for which the EPA is to identify their sources, quantify their emissions by source category, develop regulations for each source category, and assess public health and environmental impacts after the regulations are put into effect. The NTI is a tool that EPA can use to meet the CAA mandates.

### **1.3 How Is the EPA Going To Use This Version of the NTI?**

It is anticipated that the CMV and locomotive mobile source portions of the NTI will have multiple end uses. The initial objective is to make the data available to EPA modelers for use in the National Air Toxics Assessment. In addition, the emissions data compiled as part of this inventory effort will be used to prepare the air toxics portion of the annual EPA publication entitled *National Air Quality Emissions Trends Report*, which is referred to as the EPA Trends report.

## **1.4 Report Organization**

This report is organized in the following structure:

- Section 1. Provides background information on NTI and its uses;
- Section 2. Describes in general terms how CMV and locomotive mobile source emissions were estimated and allocated to individual counties;
- Section 3. Describes the limitations of the CMV and locomotive inventories;
- Section 4. Discusses the data structure used;
- Section 5. Provides the references used in the previous sections;
- Appendix A. Documents how CMV mobile source emissions were estimated for individual pollutants;
- Appendix B. Documents how locomotive mobile source emissions were estimated for individual pollutants; and
- Appendix C. Contains important references used in the CMV portion of this study, but may not be readily available to the general public (i.e., E-mail correspondence).

## **2.0 DEVELOPMENT OF THE NTI FOR CMV AND LOCOMOTIVE MOBILE SOURCES**

### **2.1 What Are CMV and Locomotive Mobile Sources?**

The CMV mobile source category includes all boats and ships used either directly or indirectly in the conduct of commerce or military activity. These include vessels ranging from 20-foot charter boats to the largest tankers and military vessels, which can exceed 1,000 feet in length (EPA, 1989). In spite of the broad range of vessels represented by this category, a number of common characteristics allow for applying a simple emission estimation method.

The majority of vessels in this category are powered either by diesel engines or steam turbines. The predominant fuel used is oil, both distillate (diesel) and residual grades, for all motorships and most steamships. In general, it can be assumed that CMVs powered by diesel engines use distillate fuel oil, and those powered by steam turbines use residual fuel oil.

The CMV source category in the NTI does not include recreational marine vessels, which generally include those vessels less than 100 feet in length, most being less than 30 feet, and powered by either inboard or outboard engines (EPA, 1989). Emissions from recreational marine vessels are included in the nonroad source category.

The locomotive mobile source category includes railroad locomotives powered by diesel-electric engines. A diesel-electric locomotive uses a diesel engine and alternator or generator to produce the electricity required to power its traction motors (EPA, 1989). The locomotive source category in the NTI does not include locomotives powered by electricity or steam. Emissions associated from electric locomotives would be included in the utility emission estimate. It is believed that the number of wood or coal driven steam locomotives is currently very small; therefore, these types of locomotives are not included in the NTI either.

## **2.2 How Were the CMV and Locomotive Emissions Estimated?**

The CMV and locomotive emission estimates provided in the inventory represent a “top-down” approach. This means that the estimates were developed by applying some measure of emissions to the port-level activity data used for the CMV source category and the state-level activity data used for the locomotive source category.

Where states provided their own emission estimates for this source categories, their data were given priority over all other data. In this version of NTI, the following state and local agencies provided commercial marine vessel or locomotive data:

- ◆ Alabama;
- ◆ Alaska;
- ◆ California (Lake County);
- ◆ Utah; and
- ◆ Puerto Rico and the Virgin Islands.

### **CMV Emission Estimates**

For the CMV source category, estimates were developed using individual port activity data for the 150 largest U.S. ports taken from the *Waterborne Commerce of the United States, Calendar Year 1996, Part 5-Waterways and Harbors National Summaries* (U.S. Army Corps of Engineers, 1999). The percentage of total traffic for each port was calculated by dividing the port-level traffic by the total traffic (all 150 ports). These percentages were then applied to the national distillate CMV VOC and PM<sub>10</sub> tons to determine the port-level VOC and PM<sub>10</sub> emissions (EPA, 1998). These percentages were also applied to the national residual fuel oil sales to determine the port-level sales. The distillate CMV VOCs and PM<sub>10</sub> emitted in port and the

gallons of residual fuel oil used in each port were then calculated based on default values recommended by EPA (EPA, 1989).

For distillate fuel oil, speciation profiles were then applied to the VOC and PM<sub>10</sub> estimates for each port. The source of the speciation profiles used for the distillate fuel oil calculations in the NTI were heavy-duty diesel vehicle (HDDV) speciation profiles derived from information provided in *Evaluation of Factors That Affect Diesel Exhaust Toxicity* (Truex and Norbeck, 1998). It was assumed that the emissions from marine vessels using distillate fuel oil were created by large diesel engines similar to those found in HDDVs.

For residual fuel oil, emission factors for stationary industrial and commercial boilers were applied to the port usage data. It was assumed that emission factors for stationary industrial and commercial boilers were an appropriate alternative, given that no HAP emission factors or speciation profiles for residual-fueled CMVs exist. The emission factors used for the residual fuel oil calculations were obtained from the EPA (Porter, 1998; EPA, 1996).

### **Locomotive Emission Estimates**

For the locomotive source category, estimates were developed using state-level distillate fuel oil sales for railroads obtained from the report *Fuel Oil and Kerosene Sales, 1996* (DOE, 1997). The fuel oil sales data were summed and applied to the individual state sales to calculate the percentage of total sales attributed to each state. These percentages were then applied to the national VOC and PM<sub>10</sub> tons to determine the VOC and PM<sub>10</sub> emissions for each state (EPA, 1997)

Speciation profiles were applied to the locomotive VOC and PM<sub>10</sub> emissions. As with the CMV emissions estimates, the source of the speciation profiles used for the locomotive estimates in this inventory were HDDV speciation profiles derived from information provided in *Evaluation of Factors That Affect Diesel Exhaust Toxicity* (Truex and Norbeck, 1998). Since locomotives

use large diesel-electric engines for propulsion and locomotive diesel speciation profiles have yet to be developed, it was assumed that the speciation profiles for HDDVs could also be used for locomotives (EPA, 1992).

### **Estimation Documentation**

More detailed documentation on how the emission estimates were prepared is provided in Appendix A for CMVs and Appendix B for locomotives. The documentation identifies the key input data that were used in the calculation of port-level emissions for CMVs and state-level emissions for locomotives. The documentation is not meant to provide an exhaustive analysis on the derivation of all the inputs. For example, an emission factor used for a port or state estimate may be given in the appendix, but the source tests that were evaluated to obtain this factor may not be presented or discussed. The goal of the documentation provided is to show in a brief and concise manner how an emission estimate was derived. Appendix C contains copies of several important and hard-to-locate references that may help the reader better appreciate the data sources used in developing the CMV estimates.

### **2.3    What Pollutants Are Included?**

The EPA's Office of Mobile Sources (OMS) identified the HAPs that are believed to be emitted from CMV and locomotive mobile sources (Cook, 1997; Cook, 1998). These HAPs, listed below, were identified based on available test data and accepted emission estimation procedures.

For CMVs, the following HAPs are included in the NTI:

Acetaldehyde	Ethylbenzene	POM as 7-PAH
Acrolein	Formaldehyde	POM as 16-PAH
Arsenic Compounds	Lead Compounds	Propionaldehyde
Benzene	Manganese Compounds	Selenium Compounds
Beryllium Compounds	Mercury Compounds	Styrene
Cadmium Compounds	n-Hexane	Toluene
Chromium Compounds	Nickel Compounds	Xylene

Note that the NTI does not include POM emissions for distillate CMVs, but they are included for residual CMVs.

For locomotives, the following HAPs are included in the NTI:

Acrolein	Ethylbenzene	Nickel	Toluene
Arsenic	Manganese	Propionaldehyde	Xylene
Chromium	n-Hexane	Styrene	

Two definitions of polycyclic organic matter (POM) are used in the NTI, 7-polycyclic aromatic hydrocarbons (7-PAH) and 16-PAH. These definitions differ from the POM definition contained in the CAA. The POM definition in Section 112(b) of the CAA, which is currently under review by EPA, is based on chemical and structural principles of the subject compounds. The CAA definition leads to the possibility of thousands of compounds that could qualify as POM. From a practical standpoint, it would not be feasible to estimate CMV mobile source emissions of all of these POM compounds.

The compounds listed below constitute the 7-PAH (marked with asterisks) and the 16-PAH group. The 7-PAH compounds have been determined by the International Agency for Research on Cancer (IARC) to be animal carcinogens. The sum of the emissions of these 7 compounds represents the 7-PAH emission subset that is used in the NTI, and the sum of the emissions of the 16 compounds represents the 16-PAH emission subset used in the NTI.

Acenaphthene	Benzo(a)pyrene*	Chrysene*	Indeno(1,2,3-cd)pyrene*
Acenaphthylene	Benzo(b)fluoranthene*	Dibenz(a,h)anthracene*	Naphthalene
Anthracene	Benzo(ghi)perylene	Fluoranthene	Phenanthrene
Benz(a)anthracene*	Benzo(k)fluoranthene*	Fluorene	Pyrene

## 2.4 What Are the Results?

Tables 2-1 and 2-2 summarize the respective 1996 CMV and locomotive mobile source emission estimates developed for each HAP.

## 2.5 How Were National Emissions Allocated to Individual Counties?

The CMV estimates were calculated using national level CMV oil sales that were allocated to the 150 largest U.S. ports based on the individual port activity (tons of freight handled). The estimates were then allocated to the counties in which each port is located. This estimation method may slightly overestimate emissions at the 150 largest ports because smaller ports were not included. This was due to a lack of available data for smaller ports.

The locomotive emissions were calculated at the state level. These emissions were then allocated to individual counties using the county proportion of state population (U.S. Department of Commerce, 1998).

**Table 2-1**  
**Summary of National 1996 CMV Emissions**

Pollutant	Emission Estimate (tons/year)
Acetaldehyde	3.57
Acrolein	83.82
Arsenic Compounds	2.02
Benzene	0.15
Beryllium Compounds	0.02
Cadmium Compounds	0.29
Chromium Compounds	10.31
Ethylbenzene	47.90
Formaldehyde	24.46
Lead Compounds	1.12
Manganese Compounds	8.19
Mercury Compounds	0.08
n-Hexane	131.72
Nickel Compounds	80.58
POM as 7-PAH	0.01
POM as 16-PAH	0.86
Propionaldehyde	146.09
Selenium Compounds	0.50
Styrene	50.29
Toluene	76.64
Xylene	114.96
<b>Total</b>	<b>783.57</b>

**Table 2-2**  
**Summary of National 1996 Locomotive Emissions**

Pollutant	Emission Estimate (tons/year)
Acrolein	167.46
Arsenic	0.01
Chromium	0.09
Ethylbenzene	95.70
Manganese	0.05
n-Hexane	263.18
Nickel	0.17
Propionaldehyde	291.87
Styrene	100.46
Toluene	153.07
Xylene	229.67
<b>Total</b>	<b>1,301.56</b>

### **3.0 What Are the Limitations of This CMV and Locomotive Inventory?**

As with the development of any emissions inventory, the accuracy of the final estimates varies considerably. Given the methods used to calculate the estimates, the most important factor influencing the quality of the estimate is the validity of the speciation profiles and emission factors used, both in terms of absolute accuracy, as well as representativeness for each engine type. This is a particular concern for CMV and locomotive sources because they include such a wide range of engine types, and no emission factors have been developed for these mobile source categories. For this reason, alternative emission speciation profiles from related engine types, had to be used to estimate emissions. While not optimal, this approach was necessary given the time and resource constraints for this inventory effort.

The activity data can also affect the quality of an emissions estimate, but activity data are usually easier to obtain and often have more credibility, especially when trying to determine port and state-level numbers.

It should also be noted that use of the surrogate 7-PAH and 16-PAH for POM may misrepresent the contribution to emissions associated with CMVs. For instance, use of a different POM surrogate may change the estimated mass of emissions significantly.

When interpreting the data at the local or state level, it is important to appreciate that this is a “top-down” inventory. The port-level emission estimates were allocated to the top 150 largest ports based on freight handled. The ports were then matched to the associated counties. State emissions for locomotives were allocated to individual counties using population as a surrogate. These approaches may underestimate emissions in some counties and may overestimate emissions in other counties depending upon the specific types of engines used. The county-level estimates are considered only a rough approximation of actual emissions. State or local CMV and locomotive emission estimates or activity data are considered to be more accurate for the counties they represent than the methods used in the NTI to disaggregate the

national-level emission to individual counties. Unfortunately, few state or local agencies have developed CMV and/or locomotive emission inventories for regulated HAPs.

## **4.0 COMPIILING THE INVENTORY DATA INTO THE NTI DATABASE**

One of the goals of this project was to process all of the inventory data into a common structure with consistently defined data fields. A common data structure can help end users of the inventory data define standardized approaches to using the data.

An essential part of this task was to format the data into a common structure so that the information could be easily defined and interpreted. It was decided that the EPA's Oracle®-based National Emissions Trends (NET) platform best served this purpose. The Oracle®-based data fields contained in the mobile source portion of the NTI are listed in Table 4-1.

**Table 4-1**  
**Data Fields in Mobile Source NTI**

Data Field				
REC_FLAG	FIPCNTRY	AMSDESC	CAS_DESC	EMISTYPE
ST_DATE	FIPSTATE	AMSCODE	CNTYEMIS	SRCETYPE
END_DATE	FIPCNTY	CAS_TXT	EM_UNITS	

The specific data structure for the NET-Oracle® platform used in this project is based on the same model developed by the Data Management Committee (DMC) of the Emission Inventory Improvement Program (EIIP), a joint program involving EPA as well as state and local agency inventory scientists and engineers. The data model developed by the EIIP DMC is intended to serve as the blueprint for the development of an electronic data transfer format that can be used to transfer data between individual facilities, state and local agencies, and the EPA. The data model was also designed to support all the emissions data needed for regional air quality modeling. More detailed information about the EIIP DMC data model, how it was designed, and

what other options are available can be found in the documentation report for the data model development (EIIP, 1999).

## 5.0 REFERENCES

Cook, Rich. Memorandum entitled *Guidance on Mobile Source Emission Estimates in the 1996 National Toxics Inventory*, to Laurel Driver and Anne Pope, U.S. EPA Office of Air Quality Planning and Standards. U.S. EPA Office of Mobile Sources. Ann Arbor, MI. June 9, 1997.

Cook, Rich. Memorandum entitled *Source Identification and Base Year 1990 Emission Inventory Guidance for Mobile Source HAPs on the OAQPS List of 40 Priority HAPs*, to Laurel Driver and Anne Pope, U.S. EPA Office of Air Quality Planning and Standards (OAQPS). U.S. EPA Office of Mobile Sources. Ann Arbor, MI. June 11, 1997.

Emission Inventory Improvement Program (EIIP). Chapter 1: EIIP Phase I Data Model. In: *EIIP Volume VII: Data Management Procedures*. EPA-454/R-97-004g. U.S. EPA Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1999.

Porter, Fred. Note entitled *Comments on Commercial/Institutional Heating Information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998*, to Anne Pope, U.S. EPA Emission Factor and Inventory Group. U.S. EPA Emission Standards Division. Research Triangle Park, NC. November 13, 1998.

Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. 1998.

U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center, Fort Belvoir, VA. Downloaded from the following Internet site:  
<http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.

U.S. Department of Commerce. *Estimates of the Population of Counties: Annual Time Series*, July 1, 1990 to July 1, 1997 (includes revised April 1, 1990 census population counts). CO-97-4. Population Estimates Program, Population Division, U.S. Bureau of Census. Washington, DC. Available at the following Internet site: <http://www.census.gov>. March 17, 1998.

U.S. Department of Energy (DOE). *Fuel Oil and Kerosene Sales, 1996*. DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration, Office of Oil and Gas, Washington, DC. Available at the following Internet site:  
[http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). 1997.

U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions from Compression Ignition Marine Engines*. EPA-420-R-98-017. Office of Mobile Sources, Engine Programs and Compliance Division. Ann Arbor, MI 1998.

U.S. Environmental Protection Agency. *Locomotive Emission Standards, Regulatory Support Document*. Office of Mobile Sources. April 1997.

U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition*, AP-42. Research Triangle Park, NC. 1996.

U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. EPA-450/4-81-026d (Revised). Office of Air and Radiation. Research Triangle Park, NC. 1992.

U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1989.

**Appendix A**

**1996 Locomotive Emissions Estimates**

---

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

---

### **Method:**

#### **Commercial Marine Vessels - 1996 National Emissions**

1996 HAP emissions from marine vessels were calculated for distillate fuel oil and residual fuel oil using the following steps. The calculations can be viewed in the attached spreadsheets.

First, the total 1996 national distillate CMV VOC and PM<sub>10</sub> emissions were obtained from the EPA's Office of Mobile Sources (OMS) (EPA, 1998) and the national vessel bunkering residual fuel oil sales were obtained from the *Fuel Oil and Kerosene Sales, 1996* report (DOE, 1997).

1996 National Distillate CMV VOC Emissions:	30,873 short tons
1996 National Distillate CMV PM <sub>10</sub> Emissions:	39,652 short tons
1996 National Vessel Bunkering Residual Fuel Oil Sales:	5,701,233 thousand gallons

Next, the amount of freight handled for the 150 largest U.S. ports was taken from *Waterborne Commerce of the United States, Calendar Year 1996, Part 5- Waterways and Harbors National Summaries* (U.S. Army Corps of Engineers, 1999). The traffic from the 150 ports listed was summed and applied to the individual port traffic totals to calculate the percentage of total traffic attributed to each port. These percentages were then applied to the national distillate CMV VOC and PM<sub>10</sub> tons to determine the port-level VOC and PM<sub>10</sub> emissions. These percentages were then applied to the national residual fuel oil sales to determine the port-level sales.

Then, the distillate CMV VOCs and PM<sub>10</sub> emitted in port and the gallons of residual fuel oil used in each port were calculated. These calculations were based on the assumption that 75 percent of the distillate oil and 25 percent of the residual oil are used in port, which are default values recommended in *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources* (U.S. EPA, 1989).

#### **Part 1: Distillate Fuel Oil**

Since emissions from marine vessels using distillate fuel oil are created by large diesel engines and marine vessel diesel speciation profiles have yet to be developed, the EPA assumed that the speciation profiles for heavy-duty diesel vehicles (HDDV) could also be used for marine vessels (Cook, 1999).

The speciation profiles were applied to the tons VOC and PM<sub>10</sub> emissions to estimate the HAP emissions from marine vessels. The HDDV speciation profiles were derived from information provided in *Evaluation of Factors That Affect Diesel Exhaust Toxicity* (Truex and Norbeck, 1998). The values given in this reference are in milligrams per brake horsepower-hour (mg/Bhp-hr). An example of how the speciation profiles were derived is as follows:

$$2.14 \text{ acrolein weighted total (mg/Bhp-hr)} / 604.91 \text{ (mg/Bhp-hr)} \text{ VOC weighted total} = \\ 0.0035 \text{ tons acrolein/tons VOC}$$

The calculations and speciation profiles for marine vessels using distillate fuel oil can be found in the attached spreadsheet labeled *Part 1: Port Distillate Fuel Oil Emissions*. Table 1 below lists the speciation profiles used to calculate the distillate fuel oil emissions.

---

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

---

**Method:****Commercial Marine Vessels - 1996 National Emissions (Continued)****Table 1: Port Distillate Fuel Oil Speciation Profiles**

Pollutant	Speciation Profile
Acrolein	0.0035 tons acrolein/VOC
Ethylbenzene	0.0020 tons ethylbenzene/VOC
n-Hexane	0.0055 tons n-hexane/VOC
Propionaldehyde	0.0061 tons propionaldehyde/VOC
Styrene	0.0021 tons styrene/VOC
Toluene	0.0032 tons toluene/VOC
Xylene	0.0048 tons xylene/VOC
Arsenic	3.57E-07 tons arsenic/PM <sub>10</sub>
Chromium	3.27E-06 tons chromium/PM <sub>10</sub>
Manganese	2.04E-06 tons manganese/PM <sub>10</sub>
Nickel	6.55E-06 tons nickel/PM <sub>10</sub>

**Part 2: Residual Fuel Oil**

Emission factors for marine vessels using residual fuel oil were obtained from the U.S. EPA (Porter, 1998; and U.S. EPA, 1996) and converted from lb/MM Btu to lb/gallon using a conversion factor of 140,000 Btu/gallon. Given that HAP emission factors or speciation profiles have yet to be developed for CMVs that use residual fuel, the emission factors that were used were derived from stationary industrial and commercial boilers. These emission factors were applied directly to the gallons of residual fuel oil used in port to estimate the HAP emissions from marine vessels using residual fuel oil. These calculations and emission factors can be found in the attached spreadsheet labeled, *Port Residual Fuel Oil Emissions*. Table 2, below, lists the emission factors used to calculate the residual fuel oil emissions.

**Table 2: Port Residual Fuel Oil Emission Factors**

Pollutant	Emission Factor (tons pollutant/10 <sup>3</sup> gallon)
Acetaldehyde	2.45E-06
Benzene	1.05E-07
Formaldehyde	1.68E-05
POM as 7-PAH	5.81E-09
POM as 16-PAH	5.88E-07
Arsenic	6.58E-07
Beryllium	1.40E-08
Cadmium	1.96E-07
Chromium	4.20E-07
Lead	7.70E-07
Manganese	1.47E-06
Mercury	5.67E-08
Nickel	4.20E-05
Selenium	3.43E-07

---

## **APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS**

---

### **Method:**

#### **Commercial Marine Vessels - 1996 National Emissions (Continued)**

#### **Allocation of Port Level HAP Emissions to Counties**

The HAP emissions from each port were then allocated to the counties in which the ports are located.

### **References**

Cook, Rich. E-mail entitled *Marine Vessel Methodology Reference - Reply*, to Teresa Kraus, Eastern Research Group, Inc. U.S. EPA Office of Mobile Sources. Ann Arbor, MI. February 24, 1999.

Porter, Fred. Note entitled *Comments on Commercial/Institutional Heating Information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998*, to Anne Pope, U.S. EPA Emission Factor and Inventory Group. U.S. EPA Emission Standards Division. Research Triangle Park, NC. November 13, 1998.

Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Downloaded from the following Internet site: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.

U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996*. DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration, Office of Oil and Gas. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.

U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions from Compression Ignition Marine Engines*. EPA-420-R-98-017. Office of Mobile Sources, Engine Programs and Compliance Division. Ann Arbor, MI. 1998.

U.S. EPA. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition*, AP-42. Research Triangle Park, North Carolina. 1996.

U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1989.

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

### **Method:**

Port Distillate Fuel Oil Emissions										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	Total National Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	National CMV VOC Emissions (short tons) <sup>2</sup>	Local Port VOC Emissions (short tons)	75% Dist. Oil Used In Port <sup>3</sup>	Total VOCs Produced in Port (short tons)
Albany	NY	36	001	5,767,708	2,422,595,044	0.24	30,873	74	75%	55
Alpena	MI	26	007	2,345,044	2,422,595,044	0.10	30,873	30	75%	22
Anacortes	WA	53	057	13,843,669	2,422,595,044	0.57	30,873	176	75%	132
Anchorage	AK	02	020	3,400,568	2,422,595,044	0.14	30,873	43	75%	33
Ashtabula	OH	39	007	9,523,147	2,422,595,044	0.39	30,873	121	75%	91
Baltimore	MD	24	510	43,552,356	2,422,595,044	1.80	30,873	555	75%	416
Barbers Point, Oahu	HI	15	003	8,745,039	2,422,595,044	0.36	30,873	111	75%	84
Baton Rouge	LA	22	033	81,009,253	2,422,595,044	3.34	30,873	1,032	75%	774
Beaumont	TX	48	245	35,705,109	2,422,595,044	1.47	30,873	455	75%	341
Bellingham	WA	53	073	1,419,257	2,422,595,044	0.06	30,873	18	75%	14
Biloxi	MS	28	047	2,266,417	2,422,595,044	0.09	30,873	29	75%	22
Boston	MA	25	025	20,103,978	2,422,595,044	0.83	30,873	256	75%	192
Bridgeport	CT	09	001	4,862,015	2,422,595,044	0.20	30,873	62	75%	46
Brownsville	TX	48	061	2,401,280	2,422,595,044	0.10	30,873	31	75%	23
Brunswick	GA	13	127	2,063,388	2,422,595,044	0.09	30,873	26	75%	20
Bucksport	ME	23	009	1,029,135	2,422,595,044	0.04	30,873	13	75%	10
Buffalo	NY	36	029	1,864,256	2,422,595,044	0.08	30,873	24	75%	18
Buffington	IN	18	089	1,242,522	2,422,595,044	0.05	30,873	16	75%	12
Burns Waterway Harbor	IN	18	127	9,847,873	2,422,595,044	0.41	30,873	125	75%	94
Calcite	MI	26	141	8,669,387	2,422,595,044	0.36	30,873	110	75%	83
Camden-Gloucester	NJ	34	007	5,765,260	2,422,595,044	0.24	30,873	73	75%	55
Charleston	SC	45	019	11,082,558	2,422,595,044	0.46	30,873	141	75%	106
Charlevoix	MI	26	029	1,665,865	2,422,595,044	0.07	30,873	21	75%	16
Chattanooga	TN	47	065	2,717,613	2,422,595,044	0.11	30,873	35	75%	26
Chester	PA	42	045	2,402,491	2,422,595,044	0.10	30,873	31	75%	23
Chicago	IL	17	031	27,886,169	2,422,595,044	1.15	30,873	355	75%	267
Cincinnati	OH	39	061	12,803,247	2,422,595,044	0.53	30,873	163	75%	122
Cleveland	OH	39	035	16,720,837	2,422,595,044	0.69	30,873	213	75%	160
Conneaut	OH	39	007	5,714,402	2,422,595,044	0.24	30,873	73	75%	55
Coos Bay	OR	41	011	3,322,218	2,422,595,044	0.14	30,873	42	75%	32
Corpus Christi	TX	48	355	80,460,088	2,422,595,044	3.32	30,873	1,025	75%	769
Detroit	MI	26	163	18,603,745	2,422,595,044	0.77	30,873	237	75%	178
Drummond Island	MI	26	033	1,681,900	2,422,595,044	0.07	30,873	21	75%	16
Duluth	MN	27	137	41,398,293	2,422,595,044	1.71	30,873	528	75%	396
Erie	PA	42	049	1,433,725	2,422,595,044	0.06	30,873	18	75%	14
Escanaba	MI	26	041	9,253,402	2,422,595,044	0.38	30,873	118	75%	88
Everett	WA	53	061	4,007,238	2,422,595,044	0.17	30,873	51	75%	38
Fairport Harbor	OH	39	085	2,770,276	2,422,595,044	0.11	30,873	35	75%	26
Fall River	MA	25	005	3,180,225	2,422,595,044	0.13	30,873	41	75%	30
Freeport	TX	48	039	24,570,954	2,422,595,044	1.01	30,873	313	75%	235

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	National CMV PM <sub>10</sub> Emissions (short tons) <sup>2</sup>	Local Port PM <sub>10</sub> Emissions (short tons)	Total PM <sub>10</sub> Produced in Port (short tons)	Tons Acrolein (0.0035 acrolein/VOC) <sup>4</sup>	Tons Ethylbenzene (0.0020 e-benzene/VOC) <sup>4</sup>	Tons n-Hexane (0.0055 n-hexane/VOC) <sup>4</sup>	Tons Propionaldehyde (0.0061 propionaldehyde/VOC) <sup>4</sup>
Albany	NY	36	001	39,652	9,440	7,080	0.19	0.11	0.30	0.34
Alpena	MI	26	007	39,652	3,838	2,879	0.08	0.04	0.12	0.14
Anacortes	WA	53	057	39,652	22,659	16,994	0.46	0.26	0.73	0.81
Anchorage	AK	02	020	39,652	5,566	4,174	0.11	0.07	0.18	0.20
Ashtabula	OH	39	007	39,652	15,587	11,690	0.32	0.18	0.50	0.56
Baltimore	MD	24	510	39,652	71,285	53,463	1.46	0.83	2.29	2.54
Barbers Point, Oahu	HI	15	003	39,652	14,314	10,735	0.29	0.17	0.46	0.51
Baton Rouge	LA	22	033	39,652	132,592	99,444	2.71	1.55	4.26	4.72
Beaumont	TX	48	245	39,652	58,441	43,830	1.19	0.68	1.88	2.08
Bellingham	WA	53	073	39,652	2,323	1,742	0.05	0.03	0.07	0.08
Biloxi	MS	28	047	39,652	3,710	2,782	0.08	0.04	0.12	0.13
Boston	MA	25	025	39,652	32,905	24,679	0.67	0.38	1.06	1.17
Bridgeport	CT	09	001	39,652	7,958	5,968	0.16	0.09	0.26	0.28
Brownsville	TX	48	061	39,652	3,930	2,948	0.08	0.05	0.13	0.14
Brunswick	GA	13	127	39,652	3,377	2,533	0.07	0.04	0.11	0.12
Bucksport	ME	23	009	39,652	1,684	1,263	0.03	0.02	0.05	0.06
Buffalo	NY	36	029	39,652	3,051	2,289	0.06	0.04	0.10	0.11
Buffington	IN	18	089	39,652	2,034	1,525	0.04	0.02	0.07	0.07
Burns Waterway Harbor	IN	18	127	39,652	16,119	12,089	0.33	0.19	0.52	0.57
Calcite	MI	26	141	39,652	14,190	10,642	0.29	0.17	0.46	0.51
Camden-Gloucester	NJ	34	007	39,652	9,436	7,077	0.19	0.11	0.30	0.34
Charleston	SC	45	019	39,652	18,139	13,605	0.37	0.21	0.58	0.65
Charlevoix	MI	26	029	39,652	2,727	2,045	0.06	0.03	0.09	0.10
Chattanooga	TN	47	065	39,652	4,448	3,336	0.09	0.05	0.14	0.16
Chester	PA	42	045	39,652	3,932	2,949	0.08	0.05	0.13	0.14
Chicago	IL	17	031	39,652	45,643	34,232	0.93	0.53	1.47	1.63
Cincinnati	OH	39	061	39,652	20,956	15,717	0.43	0.24	0.67	0.75
Cleveland	OH	39	035	39,652	27,368	20,526	0.56	0.32	0.88	0.97
Conneaut	OH	39	007	39,652	9,353	7,015	0.19	0.11	0.30	0.33
Coos Bay	OR	41	011	39,652	5,438	4,078	0.11	0.06	0.17	0.19
Corpus Christi	TX	48	355	39,652	131,694	98,770	2.69	1.54	4.23	4.69
Detroit	MI	26	163	39,652	30,450	22,837	0.62	0.36	0.98	1.08
Drummond Island	MI	26	033	39,652	2,753	2,065	0.06	0.03	0.09	0.10
Duluth	MN	27	137	39,652	67,759	50,819	1.38	0.79	2.18	2.41
Erie	PA	42	049	39,652	2,347	1,760	0.05	0.03	0.08	0.08
Escanaba	MI	26	041	39,652	15,146	11,359	0.31	0.18	0.49	0.54
Everett	WA	53	061	39,652	6,559	4,919	0.13	0.08	0.21	0.23
Fairport Harbor	OH	39	085	39,652	4,534	3,401	0.09	0.05	0.15	0.16
Fall River	MA	25	005	39,652	5,205	3,904	0.11	0.06	0.17	0.19
Freeport	TX	48	039	39,652	40,217	30,163	0.82	0.47	1.29	1.43

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## **Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Tons Styrene (0.0021 styrene/VOC) <sup>4</sup>	Tons Toluene (0.0032 toluene/VOC) <sup>4</sup>	Tons Xylene (0.0048 xylene/VOC) <sup>4</sup>	Tons Arsenic (3.57E-07 arsenic/PM <sub>10</sub> ) <sup>4</sup>	Tons Chromium (3.27E-06 chromium/PM <sub>10</sub> ) <sup>4</sup>	Tons Manganese (2.04E-06 manganese/PM <sub>10</sub> ) <sup>4</sup>	Tons Nickel (6.55E-06 nickel/PM <sub>10</sub> ) <sup>4</sup>
Albany	NY	36	001	0.12	0.18	0.26	2.53E-03	2.32E-02	1.44E-02	4.64E-02
Alpena	MI	26	007	0.05	0.07	0.11	1.03E-03	9.41E-03	5.87E-03	1.89E-02
Anacortes	WA	53	057	0.28	0.42	0.64	6.07E-03	5.56E-02	3.47E-02	1.11E-01
Anchorage	AK	02	020	0.07	0.10	0.16	1.49E-03	1.37E-02	8.52E-03	2.73E-02
Ashtabula	OH	39	007	0.19	0.29	0.44	4.17E-03	3.82E-02	2.38E-02	7.66E-02
Baltimore	MD	24	510	0.87	1.33	2.00	1.91E-02	1.75E-01	1.09E-01	3.50E-01
Barbers Point, Oahu	HI	15	003	0.18	0.27	0.40	3.83E-03	3.51E-02	2.19E-02	7.03E-02
Baton Rouge	LA	22	033	1.63	2.48	3.72	3.55E-02	3.25E-01	2.03E-01	6.51E-01
Beaumont	TX	48	245	0.72	1.09	1.64	1.56E-02	1.43E-01	8.94E-02	2.87E-01
Bellingham	WA	53	073	0.03	0.04	0.07	6.22E-04	5.70E-03	3.55E-03	1.14E-02
Biloxi	MS	28	047	0.05	0.07	0.10	9.93E-04	9.10E-03	5.68E-03	1.82E-02
Boston	MA	25	025	0.40	0.61	0.92	8.81E-03	8.07E-02	5.03E-02	1.62E-01
Bridgeport	CT	09	001	0.10	0.15	0.22	2.13E-03	1.95E-02	1.22E-02	3.91E-02
Brownsville	TX	48	061	0.05	0.07	0.11	1.05E-03	9.64E-03	6.01E-03	1.93E-02
Brunswick	GA	13	127	0.04	0.06	0.09	9.04E-04	8.28E-03	5.17E-03	1.66E-02
Bucksport	ME	23	009	0.02	0.03	0.05	4.51E-04	4.13E-03	2.58E-03	8.27E-03
Buffalo	NY	36	029	0.04	0.06	0.09	8.17E-04	7.48E-03	4.67E-03	1.50E-02
Buffington	IN	18	089	0.02	0.04	0.06	5.45E-04	4.99E-03	3.11E-03	9.99E-03
Burns Waterway Harbor	IN	18	127	0.20	0.30	0.45	4.32E-03	3.95E-02	2.47E-02	7.92E-02
Calcite	MI	26	141	0.17	0.27	0.40	3.80E-03	3.48E-02	2.17E-02	6.97E-02
Camden-Glocester	NJ	34	007	0.12	0.18	0.26	2.53E-03	2.31E-02	1.44E-02	4.64E-02
Charleston	SC	45	019	0.22	0.34	0.51	4.86E-03	4.45E-02	2.78E-02	8.91E-02
Charlevoix	MI	26	029	0.03	0.05	0.08	7.30E-04	6.69E-03	4.17E-03	1.34E-02
Chattanooga	TN	47	065	0.05	0.08	0.12	1.19E-03	1.09E-02	6.81E-03	2.19E-02
Chester	PA	42	045	0.05	0.07	0.11	1.05E-03	9.64E-03	6.02E-03	1.93E-02
Chicago	IL	17	031	0.56	0.85	1.28	1.22E-02	1.12E-01	6.98E-02	2.24E-01
Cincinnati	OH	39	061	0.26	0.39	0.59	5.61E-03	5.14E-02	3.21E-02	1.03E-01
Cleveland	OH	39	035	0.34	0.51	0.77	7.33E-03	6.71E-02	4.19E-02	1.34E-01
Conneaut	OH	39	007	0.11	0.17	0.26	2.50E-03	2.29E-02	1.43E-02	4.59E-02
Coos Bay	OR	41	011	0.07	0.10	0.15	1.46E-03	1.33E-02	8.32E-03	2.67E-02
Corpus Christi	TX	48	355	1.61	2.46	3.69	3.53E-02	3.23E-01	2.01E-01	6.47E-01
Detroit	MI	26	163	0.37	0.57	0.85	8.15E-03	7.47E-02	4.66E-02	1.50E-01
Drummond Island	MI	26	033	0.03	0.05	0.08	7.37E-04	6.75E-03	4.21E-03	1.35E-02
Duluth	MN	27	137	0.83	1.27	1.90	1.81E-02	1.66E-01	1.04E-01	3.33E-01
Erie	PA	42	049	0.03	0.04	0.07	6.28E-04	5.76E-03	3.59E-03	1.15E-02
Escanaba	MI	26	041	0.19	0.28	0.42	4.06E-03	3.71E-02	2.32E-02	7.44E-02
Everett	WA	53	061	0.08	0.12	0.18	1.76E-03	1.61E-02	1.00E-02	3.22E-02
Fairport Harbor	OH	39	085	0.06	0.08	0.13	1.21E-03	1.11E-02	6.94E-03	2.23E-02
Fall River	MA	25	005	0.06	0.10	0.15	1.39E-03	1.28E-02	7.96E-03	2.56E-02
Freeport	TX	48	039	0.49	0.75	1.13	1.08E-02	9.86E-02	6.15E-02	1.98E-01

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	Total National Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	National CMV VOC Emissions (short tons) <sup>2</sup>	Local Port VOC Emissions (short tons)	75% Dist. Oil Used In Port <sup>3</sup>	Total VOCs Produced in Port (short tons)
Galveston	TX	48	167	11,640,754	2,422,595,044	0.48	30,873	148	75%	111
Gary	IN	18	089	8,882,164	2,422,595,044	0.37	30,873	113	75%	85
Georgetown	SC	45	043	1,379,408	2,422,595,044	0.06	30,873	18	75%	13
Grays Harbor	WA	53	027	1,990,077	2,422,595,044	0.08	30,873	25	75%	19
Green Bay	WI	55	009	2,176,192	2,422,595,044	0.09	30,873	28	75%	21
Greenville	MS	28	151	2,543,382	2,422,595,044	0.10	30,873	32	75%	24
Gulfport	MS	28	047	2,123,671	2,422,595,044	0.09	30,873	27	75%	20
Guntersville	AL	01	095	2,597,760	2,422,595,044	0.11	30,873	33	75%	25
Helena	AR	05	107	2,285,638	2,422,595,044	0.09	30,873	29	75%	22
Hempstead	NY	36	059	1,329,385	2,422,595,044	0.05	30,873	17	75%	13
Hilo	HI	15	001	1,441,507	2,422,595,044	0.06	30,873	18	75%	14
Honolulu	HI	15	003	12,010,003	2,422,595,044	0.50	30,873	153	75%	115
Hopewell	VA	51	670	1,394,904	2,422,595,044	0.06	30,873	18	75%	13
Houston	TX	48	201	148,182,876	2,422,595,044	6.12	30,873	1,888	75%	1,416
Humboldt	CA	06	023	1,196,796	2,422,595,044	0.05	30,873	15	75%	11
Huntington	WV	54	011	27,478,215	2,422,595,044	1.13	30,873	350	75%	263
Huron	OH	39	043	1,003,830	2,422,595,044	0.04	30,873	13	75%	10
Indiana Harbor	IN	18	089	16,892,858	2,422,595,044	0.70	30,873	215	75%	161
Jacksonville	FL	12	031	16,736,773	2,422,595,044	0.69	30,873	213	75%	160
Kahului, Maui	HI	15	009	2,827,806	2,422,595,044	0.12	30,873	36	75%	27
Kalama	WA	53	015	8,222,919	2,422,595,044	0.34	30,873	105	75%	79
Kansas City	MO	29	095	3,009,981	2,422,595,044	0.12	30,873	38	75%	29
Ketchikan	AK	02	130	1,340,609	2,422,595,044	0.06	30,873	17	75%	13
Lake Charles	LA	22	019	49,096,325	2,422,595,044	2.03	30,873	626	75%	469
Long Beach	CA	06	037	58,395,243	2,422,595,044	2.41	30,873	744	75%	558
Longview	WA	53	015	5,162,634	2,422,595,044	0.21	30,873	66	75%	49
Lorain	OH	39	093	15,977,949	2,422,595,044	0.66	30,873	204	75%	153
Los Angeles	CA	06	037	45,689,232	2,422,595,044	1.89	30,873	582	75%	437
Louisville	KY	21	111	8,779,342	2,422,595,044	0.36	30,873	112	75%	84
Ludington	MI	26	105	1,236,834	2,422,595,044	0.05	30,873	16	75%	12
Marblehead	OH	39	123	2,816,540	2,422,595,044	0.12	30,873	36	75%	27
Marcus Hook	PA	42	045	12,365,946	2,422,595,044	0.51	30,873	158	75%	118
Marine City	MI	26	147	4,116,212	2,422,595,044	0.17	30,873	52	75%	39
Marquette	MI	26	103	1,598,125	2,422,595,044	0.07	30,873	20	75%	15
Marysville	MI	26	147	1,067,783	2,422,595,044	0.04	30,873	14	75%	10
Matagorda Ship Channel	TX	48	321	9,151,450	2,422,595,044	0.38	30,873	117	75%	87
Memphis	TN	47	157	17,299,836	2,422,595,044	0.71	30,873	220	75%	165
Miami	FL	12	025	5,719,107	2,422,595,044	0.24	30,873	73	75%	55
Milwaukee	WI	55	079	2,858,231	2,422,595,044	0.12	30,873	36	75%	27
Minneapolis	MN	27	053	1,567,477	2,422,595,044	0.06	30,873	20	75%	15
Mobile	AL	01	097	50,863,944	2,422,595,044	2.10	30,873	648	75%	486
Monroe	MI	26	115	1,794,335	2,422,595,044	0.07	30,873	23	75%	17

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	National CMV PM <sub>10</sub> Emissions (short tons) <sup>2</sup>	Local Port PM <sub>10</sub> Emissions (short tons)	Total PM <sub>10</sub> Produced in Port (short tons)	Tons Acrolein (0.0035 acrolein/VOC) <sup>4</sup>	Tons Ethylbenzene (0.0020 e-benzene/VOC) <sup>4</sup>	Tons n-Hexane (0.0055 n-hexane/VOC) <sup>4</sup>	Tons Propionaldehyde (0.0061 propionaldehyde/VOC) <sup>4</sup>
Galveston	TX	48	167	39,652	19,053	14,290	0.39	0.22	0.61	0.68
Gary	IN	18	089	39,652	14,538	10,903	0.30	0.17	0.47	0.52
Georgetown	SC	45	043	39,652	2,258	1,693	0.05	0.03	0.07	0.08
Grays Harbor	WA	53	027	39,652	3,257	2,443	0.07	0.04	0.10	0.12
Green Bay	WI	55	009	39,652	3,562	2,671	0.07	0.04	0.11	0.13
Greenville	MS	28	151	39,652	4,163	3,122	0.09	0.05	0.13	0.15
Gulfport	MS	28	047	39,652	3,476	2,607	0.07	0.04	0.11	0.12
Guntersville	AL	01	095	39,652	4,252	3,189	0.09	0.05	0.14	0.15
Helena	AR	05	107	39,652	3,741	2,806	0.08	0.04	0.12	0.13
Hempstead	NY	36	059	39,652	2,176	1,632	0.04	0.03	0.07	0.08
Hilo	HI	15	001	39,652	2,359	1,770	0.05	0.03	0.08	0.08
Honolulu	HI	15	003	39,652	19,657	14,743	0.40	0.23	0.63	0.70
Hopewell	VA	51	670	39,652	2,283	1,712	0.05	0.03	0.07	0.08
Houston	TX	48	201	39,652	242,539	181,905	4.96	2.83	7.79	8.64
Humboldt	CA	06	023	39,652	1,959	1,469	0.04	0.02	0.06	0.07
Huntington	WV	54	011	39,652	44,975	33,731	0.92	0.53	1.44	1.60
Huron	OH	39	043	39,652	1,643	1,232	0.03	0.02	0.05	0.06
Indiana Harbor	IN	18	089	39,652	27,650	20,737	0.57	0.32	0.89	0.98
Jacksonville	FL	12	031	39,652	27,394	20,546	0.56	0.32	0.88	0.98
Kahului, Maui	HI	15	009	39,652	4,628	3,471	0.09	0.05	0.15	0.16
Kalama	WA	53	015	39,652	13,459	10,094	0.28	0.16	0.43	0.48
Kansas City	MO	29	095	39,652	4,927	3,695	0.10	0.06	0.16	0.18
Ketchikan	AK	02	130	39,652	2,194	1,646	0.04	0.03	0.07	0.08
Lake Charles	LA	22	019	39,652	80,359	60,269	1.64	0.94	2.58	2.86
Long Beach	CA	06	037	39,652	95,579	71,684	1.95	1.12	3.07	3.40
Longview	WA	53	015	39,652	8,450	6,337	0.17	0.10	0.27	0.30
Lorain	OH	39	093	39,652	26,152	19,614	0.53	0.31	0.84	0.93
Los Angeles	CA	06	037	39,652	74,782	56,087	1.53	0.87	2.40	2.66
Louisville	KY	21	111	39,652	14,370	10,777	0.29	0.17	0.46	0.51
Ludington	MI	26	105	39,652	2,024	1,518	0.04	0.02	0.07	0.07
Marblehead	OH	39	123	39,652	4,610	3,457	0.09	0.05	0.15	0.16
Marcus Hook	PA	42	045	39,652	20,240	15,180	0.41	0.24	0.65	0.72
Marine City	MI	26	147	39,652	6,737	5,053	0.14	0.08	0.22	0.24
Marquette	MI	26	103	39,652	2,616	1,962	0.05	0.03	0.08	0.09
Marysville	MI	26	147	39,652	1,748	1,311	0.04	0.02	0.06	0.06
Matagorda Ship Channel	TX	48	321	39,652	14,979	11,234	0.31	0.17	0.48	0.53
Memphis	TN	47	157	39,652	28,316	21,237	0.58	0.33	0.91	1.01
Miami	FL	12	025	39,652	9,361	7,021	0.19	0.11	0.30	0.33
Milwaukee	WI	55	079	39,652	4,678	3,509	0.10	0.05	0.15	0.17
Minneapolis	MN	27	053	39,652	2,566	1,924	0.05	0.03	0.08	0.09
Mobile	AL	01	097	39,652	83,252	62,439	1.70	0.97	2.67	2.97
Monroe	MI	26	115	39,652	2,937	2,203	0.06	0.03	0.09	0.10

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Tons Styrene (0.0021 styrene/VOC) <sup>4</sup>	Tons Toluene (0.0032 toluene/VOC) <sup>4</sup>	Tons Xylene (0.0048 xylene/VOC) <sup>4</sup>	Tons Arsenic (3.57E-07 arsenic/PM <sub>10</sub> ) <sup>4</sup>	Tons Chromium (3.27E-06 chromium/PM <sub>10</sub> ) <sup>4</sup>	Tons Manganese (2.04E-06 manganese/PM <sub>10</sub> ) <sup>4</sup>	Tons Nickel (6.55E-06 nickel/PM <sub>10</sub> ) <sup>4</sup>
Galveston	TX	48	167	0.23	0.36	0.53	5.10E-03	4.67E-02	2.92E-02	9.36E-02
Gary	IN	18	089	0.18	0.27	0.41	3.89E-03	3.57E-02	2.22E-02	7.14E-02
Georgetown	SC	45	043	0.03	0.04	0.06	6.05E-04	5.54E-03	3.45E-03	1.11E-02
Grays Harbor	WA	53	027	0.04	0.06	0.09	8.72E-04	7.99E-03	4.98E-03	1.60E-02
Green Bay	WI	55	009	0.04	0.07	0.10	9.54E-04	8.74E-03	5.45E-03	1.75E-02
Greenville	MS	28	151	0.05	0.08	0.12	1.11E-03	1.02E-02	6.37E-03	2.05E-02
Gulfport	MS	28	047	0.04	0.06	0.10	9.31E-04	8.52E-03	5.32E-03	1.71E-02
Guntersville	AL	01	095	0.05	0.08	0.12	1.14E-03	1.04E-02	6.51E-03	2.09E-02
Helena	AR	05	107	0.05	0.07	0.10	1.00E-03	9.17E-03	5.72E-03	1.84E-02
Hempstead	NY	36	059	0.03	0.04	0.06	5.83E-04	5.34E-03	3.33E-03	1.07E-02
Hilo	HI	15	001	0.03	0.04	0.07	6.32E-04	5.79E-03	3.61E-03	1.16E-02
Honolulu	HI	15	003	0.24	0.37	0.55	5.26E-03	4.82E-02	3.01E-02	9.66E-02
Hopewell	VA	51	670	0.03	0.04	0.06	6.11E-04	5.60E-03	3.49E-03	1.12E-02
Houston	TX	48	201	2.97	4.53	6.80	6.49E-02	5.95E-01	3.71E-01	1.19E+00
Humboldt	CA	06	023	0.02	0.04	0.05	5.24E-04	4.80E-03	3.00E-03	9.62E-03
Huntington	WV	54	011	0.55	0.84	1.26	1.20E-02	1.10E-01	6.88E-02	2.21E-01
Huron	OH	39	043	0.02	0.03	0.05	4.40E-04	4.03E-03	2.51E-03	8.07E-03
Indiana Harbor	IN	18	089	0.34	0.52	0.78	7.40E-03	6.78E-02	4.23E-02	1.36E-01
Jacksonville	FL	12	031	0.34	0.51	0.77	7.33E-03	6.72E-02	4.19E-02	1.35E-01
Kahului, Maui	HI	15	009	0.06	0.09	0.13	1.24E-03	1.14E-02	7.08E-03	2.27E-02
Kalama	WA	53	015	0.17	0.25	0.38	3.60E-03	3.30E-02	2.06E-02	6.61E-02
Kansas City	MO	29	095	0.06	0.09	0.14	1.32E-03	1.21E-02	7.54E-03	2.42E-02
Ketchikan	AK	02	130	0.03	0.04	0.06	5.88E-04	5.38E-03	3.36E-03	1.08E-02
Lake Charles	LA	22	019	0.99	1.50	2.25	2.15E-02	1.97E-01	1.23E-01	3.95E-01
Long Beach	CA	06	037	1.17	1.79	2.68	2.56E-02	2.34E-01	1.46E-01	4.70E-01
Longview	WA	53	015	0.10	0.16	0.24	2.26E-03	2.07E-02	1.29E-02	4.15E-02
Lorain	OH	39	093	0.32	0.49	0.73	7.00E-03	6.41E-02	4.00E-02	1.28E-01
Los Angeles	CA	06	037	0.92	1.40	2.10	2.00E-02	1.83E-01	1.14E-01	3.67E-01
Louisville	KY	21	111	0.18	0.27	0.40	3.85E-03	3.52E-02	2.20E-02	7.06E-02
Ludington	MI	26	105	0.02	0.04	0.06	5.42E-04	4.96E-03	3.10E-03	9.94E-03
Marblehead	OH	39	123	0.06	0.09	0.13	1.23E-03	1.13E-02	7.05E-03	2.26E-02
Marcus Hook	PA	42	045	0.25	0.38	0.57	5.42E-03	4.96E-02	3.10E-02	9.94E-02
Marine City	MI	26	147	0.08	0.13	0.19	1.80E-03	1.65E-02	1.03E-02	3.31E-02
Marquette	MI	26	103	0.03	0.05	0.07	7.00E-04	6.42E-03	4.00E-03	1.28E-02
Marysville	MI	26	147	0.02	0.03	0.05	4.68E-04	4.29E-03	2.67E-03	8.59E-03
Matagorda Ship Channel	TX	48	321	0.18	0.28	0.42	4.01E-03	3.67E-02	2.29E-02	7.36E-02
Memphis	TN	47	157	0.35	0.53	0.79	7.58E-03	6.94E-02	4.33E-02	1.39E-01
Miami	FL	12	025	0.11	0.17	0.26	2.51E-03	2.30E-02	1.43E-02	4.60E-02
Milwaukee	WI	55	079	0.06	0.09	0.13	1.25E-03	1.15E-02	7.16E-03	2.30E-02
Minneapolis	MN	27	053	0.03	0.05	0.07	6.87E-04	6.29E-03	3.93E-03	1.26E-02
Mobile	AL	01	097	1.02	1.56	2.33	2.23E-02	2.04E-01	1.27E-01	4.09E-01
Monroe	MI	26	115	0.04	0.05	0.08	7.86E-04	7.20E-03	4.49E-03	1.44E-02

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	Total National Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	National CMV VOC Emissions (short tons) <sup>2</sup>	Local Port VOC Emissions (short tons)	75% Dist. Oil Used In Port <sup>3</sup>	Total VOCs Produced in Port (short tons)
Morehead City	NC	37	031	5,540,766	2,422,595,044	0.23	30,873	71	75%	53
Mount Vernon	IN	18	129	6,985,531	2,422,595,044	0.29	30,873	89	75%	67
Muskegon	MI	26	121	2,172,075	2,422,595,044	0.09	30,873	28	75%	21
Nashville	TN	47	037	3,777,854	2,422,595,044	0.16	30,873	48	75%	36
Nawiliwili, Kauai	HI	15	007	1,203,276	2,422,595,044	0.05	30,873	15	75%	12
New Castle	DE	10	003	9,377,080	2,422,595,044	0.39	30,873	119	75%	90
New Haven	CT	09	009	8,838,093	2,422,595,044	0.36	30,873	113	75%	84
New Orleans	LA	22	071	83,726,470	2,422,595,044	3.46	30,873	1,067	75%	800
New York	NY	36	065	131,601,244	2,422,595,044	5.43	30,873	1,677	75%	1,258
Newport News	VA	51	700	24,787,261	2,422,595,044	1.02	30,873	316	75%	237
Nikishka	AK	02	290	5,049,883	2,422,595,044	0.21	30,873	64	75%	48
Norfolk Harbor	VA	51	710	49,260,972	2,422,595,044	2.03	30,873	628	75%	471
Oakland	CA	06	001	11,229,862	2,422,595,044	0.46	30,873	143	75%	107
Olympia	WA	53	067	1,893,029	2,422,595,044	0.08	30,873	24	75%	18
Palm Beach	FL	12	099	2,293,615	2,422,595,044	0.09	30,873	29	75%	22
Panama City	FL	12	005	3,123,941	2,422,595,044	0.13	30,873	40	75%	30
Pascagoula	MS	28	059	29,342,671	2,422,595,044	1.21	30,873	374	75%	280
Paulsboro	NJ	34	015	25,038,524	2,422,595,044	1.03	30,873	319	75%	239
Pensacola	FL	12	033	1,378,971	2,422,595,044	0.06	30,873	18	75%	13
Philadelphia	PA	42	101	41,882,200	2,422,595,044	1.73	30,873	534	75%	400
Pittsburgh	PA	42	003	50,874,367	2,422,595,044	2.10	30,873	648	75%	486
Plaquemines, Port of	LA	22	047	66,910,237	2,422,595,044	2.76	30,873	853	75%	640
Port Angeles	WA	53	009	2,780,081	2,422,595,044	0.11	30,873	35	75%	27
Port Arthur	TX	48	245	37,157,786	2,422,595,044	1.53	30,873	474	75%	355
Port Canaveral	FL	12	009	3,566,630	2,422,595,044	0.15	30,873	45	75%	34
Port Dolomite	MI	26	097	3,318,441	2,422,595,044	0.14	30,873	42	75%	32
Port Everglades	FL	12	011	18,896,571	2,422,595,044	0.78	30,873	241	75%	181
Port Inland	MI	26	153	5,062,723	2,422,595,044	0.21	30,873	65	75%	48
Port Jefferson	NY	36	103	2,988,115	2,422,595,044	0.12	30,873	38	75%	29
Portland	ME	23	005	15,242,802	2,422,595,044	0.63	30,873	194	75%	146
Portland	OR	41	051	29,733,913	2,422,595,044	1.23	30,873	379	75%	284
Portsmouth	NH	33	015	3,708,169	2,422,595,044	0.15	30,873	47	75%	35
Presque Isle	MI	26	141	8,958,976	2,422,595,044	0.37	30,873	114	75%	86
Providence	RI	44	007	7,802,779	2,422,595,044	0.32	30,873	99	75%	75
Redwood City	CA	06	081	985,392	2,422,595,044	0.04	30,873	13	75%	9
Richmond	CA	06	013	21,802,748	2,422,595,044	0.90	30,873	278	75%	208
Richmond	VA	51	760	1,499,218	2,422,595,044	0.06	30,873	19	75%	14
Sacramento	CA	06	067	1,239,858	2,422,595,044	0.05	30,873	16	75%	12
Salem	MA	25	009	1,431,771	2,422,595,044	0.06	30,873	18	75%	14
San Diego	CA	06	073	1,842,040	2,422,595,044	0.08	30,873	23	75%	18
San Francisco	CA	06	075	1,982,145	2,422,595,044	0.08	30,873	25	75%	19
San Juan	PR	72	127	15,112,223	2,422,595,044	0.62	30,873	193	75%	144
Sandusky	OH	39	043	3,408,357	2,422,595,044	0.14	30,873	43	75%	33

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## **Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	Total National Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	National CMV VOC Emissions (short tons) <sup>2</sup>	Local Port VOC Emissions (short tons)	75% Dist. Oil Used In Port <sup>3</sup>	Total VOCs Produced in Port (short tons)
Morehead City	NC	37	031	5,540,766	2,422,595,044	0.23	30,873	71	75%	53
Mount Vernon	IN	18	129	6,985,531	2,422,595,044	0.29	30,873	89	75%	67
Muskegon	MI	26	121	2,172,075	2,422,595,044	0.09	30,873	28	75%	21
Nashville	TN	47	037	3,777,854	2,422,595,044	0.16	30,873	48	75%	36
Nawiliwili, Kauai	HI	15	007	1,203,276	2,422,595,044	0.05	30,873	15	75%	12
New Castle	DE	10	003	9,377,080	2,422,595,044	0.39	30,873	119	75%	90
New Haven	CT	09	009	8,838,093	2,422,595,044	0.36	30,873	113	75%	84
New Orleans	LA	22	071	83,726,470	2,422,595,044	3.46	30,873	1,067	75%	800
New York	NY	36	065	131,601,244	2,422,595,044	5.43	30,873	1,677	75%	1,258
Newport News	VA	51	700	24,787,261	2,422,595,044	1.02	30,873	316	75%	237
Nikishka	AK	02	290	5,049,883	2,422,595,044	0.21	30,873	64	75%	48
Norfolk Harbor	VA	51	710	49,260,972	2,422,595,044	2.03	30,873	628	75%	471
Oakland	CA	06	001	11,229,862	2,422,595,044	0.46	30,873	143	75%	107
Olympia	WA	53	067	1,893,029	2,422,595,044	0.08	30,873	24	75%	18
Palm Beach	FL	12	099	2,293,615	2,422,595,044	0.09	30,873	29	75%	22
Panama City	FL	12	005	3,123,941	2,422,595,044	0.13	30,873	40	75%	30
Pascagoula	MS	28	059	29,342,671	2,422,595,044	1.21	30,873	374	75%	280
Paulsboro	NJ	34	015	25,038,524	2,422,595,044	1.03	30,873	319	75%	239
Pensacola	FL	12	033	1,378,971	2,422,595,044	0.06	30,873	18	75%	13
Philadelphia	PA	42	101	41,882,200	2,422,595,044	1.73	30,873	534	75%	400
Pittsburgh	PA	42	003	50,874,367	2,422,595,044	2.10	30,873	648	75%	486
Plaquemines, Port of	LA	22	047	66,910,237	2,422,595,044	2.76	30,873	853	75%	640
Port Angeles	WA	53	009	2,780,081	2,422,595,044	0.11	30,873	35	75%	27
Port Arthur	TX	48	245	37,157,786	2,422,595,044	1.53	30,873	474	75%	355
Port Canaveral	FL	12	009	3,566,630	2,422,595,044	0.15	30,873	45	75%	34
Port Dolomite	MI	26	097	3,318,441	2,422,595,044	0.14	30,873	42	75%	32
Port Everglades	FL	12	011	18,896,571	2,422,595,044	0.78	30,873	241	75%	181
Port Inland	MI	26	153	5,062,723	2,422,595,044	0.21	30,873	65	75%	48
Port Jefferson	NY	36	103	2,988,115	2,422,595,044	0.12	30,873	38	75%	29
Portland	ME	23	005	15,242,802	2,422,595,044	0.63	30,873	194	75%	146
Portland	OR	41	051	29,733,913	2,422,595,044	1.23	30,873	379	75%	284
Portsmouth	NH	33	015	3,708,169	2,422,595,044	0.15	30,873	47	75%	35
Presque Isle	MI	26	141	8,958,976	2,422,595,044	0.37	30,873	114	75%	86
Providence	RI	44	007	7,802,779	2,422,595,044	0.32	30,873	99	75%	75
Redwood City	CA	06	081	985,392	2,422,595,044	0.04	30,873	13	75%	9
Richmond	CA	06	013	21,802,748	2,422,595,044	0.90	30,873	278	75%	208
Richmond	VA	51	760	1,499,218	2,422,595,044	0.06	30,873	19	75%	14
Sacramento	CA	06	067	1,239,858	2,422,595,044	0.05	30,873	16	75%	12
Salem	MA	25	009	1,431,771	2,422,595,044	0.06	30,873	18	75%	14
San Diego	CA	06	073	1,842,040	2,422,595,044	0.08	30,873	23	75%	18
San Francisco	CA	06	075	1,982,145	2,422,595,044	0.08	30,873	25	75%	19
San Juan	PR	72	127	15,112,223	2,422,595,044	0.62	30,873	193	75%	144
Sandusky	OH	39	043	3,408,357	2,422,595,044	0.14	30,873	43	75%	33

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Tons Styrene (0.0021 styrene/VOC) <sup>4</sup>	Tons Toluene (0.0032 toluene/VOC) <sup>4</sup>	Tons Xylene (0.0048 xylene/VOC) <sup>4</sup>	Tons Arsenic (3.57E-07 arsenic/PM <sub>10</sub> ) <sup>4</sup>	Tons Chromium (3.27E-06 chromium/PM <sub>10</sub> ) <sup>4</sup>	Tons Manganese (2.04E-06 manganese/PM <sub>10</sub> ) <sup>4</sup>	Tons Nickel (6.55E-06 nickel/PM <sub>10</sub> ) <sup>4</sup>
Morehead City	NC	37	031	0.11	0.17	0.25	2.43E-03	2.22E-02	1.39E-02	4.46E-02
Mount Vernon	IN	18	129	0.14	0.21	0.32	3.06E-03	2.80E-02	1.75E-02	5.62E-02
Muskegon	MI	26	121	0.04	0.07	0.10	9.52E-04	8.72E-03	5.44E-03	1.75E-02
Nashville	TN	47	037	0.08	0.12	0.17	1.66E-03	1.52E-02	9.46E-03	3.04E-02
Nawiliwili, Kauai	HI	15	007	0.02	0.04	0.06	5.27E-04	4.83E-03	3.01E-03	9.68E-03
New Castle	DE	10	003	0.19	0.29	0.43	4.11E-03	3.76E-02	2.35E-02	7.54E-02
New Haven	CT	09	009	0.18	0.27	0.41	3.87E-03	3.55E-02	2.21E-02	7.11E-02
New Orleans	LA	22	071	1.68	2.56	3.84	3.67E-02	3.36E-01	2.10E-01	6.73E-01
New York	NY	36	065	2.64	4.03	6.04	5.77E-02	5.28E-01	3.30E-01	1.06E+00
Newport News	VA	51	700	0.50	0.76	1.14	1.09E-02	9.95E-02	6.21E-02	1.99E-01
Nikishka	AK	02	290	0.10	0.15	0.23	2.21E-03	2.03E-02	1.26E-02	4.06E-02
Norfolk Harbor	VA	51	710	0.99	1.51	2.26	2.16E-02	1.98E-01	1.23E-01	3.96E-01
Oakland	CA	06	001	0.23	0.34	0.52	4.92E-03	4.51E-02	2.81E-02	9.03E-02
Olympia	WA	53	067	0.04	0.06	0.09	8.30E-04	7.60E-03	4.74E-03	1.52E-02
Palm Beach	FL	12	099	0.05	0.07	0.11	1.01E-03	9.21E-03	5.74E-03	1.84E-02
Panama City	FL	12	005	0.06	0.10	0.14	1.37E-03	1.25E-02	7.82E-03	2.51E-02
Pascagoula	MS	28	059	0.59	0.90	1.35	1.29E-02	1.18E-01	7.35E-02	2.36E-01
Paulsboro	NJ	34	015	0.50	0.77	1.15	1.10E-02	1.01E-01	6.27E-02	2.01E-01
Pensacola	FL	12	033	0.03	0.04	0.06	6.04E-04	5.54E-03	3.45E-03	1.11E-02
Philadelphia	PA	42	101	0.84	1.28	1.92	1.84E-02	1.68E-01	1.05E-01	3.37E-01
Pittsburgh	PA	42	003	1.02	1.56	2.33	2.23E-02	2.04E-01	1.27E-01	4.09E-01
Plaquemines, Port of	LA	22	047	1.34	2.05	3.07	2.93E-02	2.69E-01	1.68E-01	5.38E-01
Port Angeles	WA	53	009	0.06	0.09	0.13	1.22E-03	1.12E-02	6.96E-03	2.24E-02
Port Arthur	TX	48	245	0.75	1.14	1.70	1.63E-02	1.49E-01	9.31E-02	2.99E-01
Port Canaveral	FL	12	009	0.07	0.11	0.16	1.56E-03	1.43E-02	8.93E-03	2.87E-02
Port Dolomite	MI	26	097	0.07	0.10	0.15	1.45E-03	1.33E-02	8.31E-03	2.67E-02
Port Everglades	FL	12	011	0.38	0.58	0.87	8.28E-03	7.59E-02	4.73E-02	1.52E-01
Port Inland	MI	26	153	0.10	0.15	0.23	2.22E-03	2.03E-02	1.27E-02	4.07E-02
Port Jefferson	NY	36	103	0.06	0.09	0.14	1.31E-03	1.20E-02	7.48E-03	2.40E-02
Portland	ME	23	005	0.31	0.47	0.70	6.68E-03	6.12E-02	3.82E-02	1.23E-01
Portland	OR	41	051	0.60	0.91	1.36	1.30E-02	1.19E-01	7.45E-02	2.39E-01
Portsmouth	NH	33	015	0.07	0.11	0.17	1.63E-03	1.49E-02	9.29E-03	2.98E-02
Presque Isle	MI	26	141	0.18	0.27	0.41	3.93E-03	3.60E-02	2.24E-02	7.20E-02
Providence	RI	44	007	0.16	0.24	0.36	3.42E-03	3.13E-02	1.95E-02	6.27E-02
Redwood City	CA	06	081	0.02	0.03	0.05	4.32E-04	3.96E-03	2.47E-03	7.92E-03
Richmond	CA	06	013	0.44	0.67	1.00	9.55E-03	8.75E-02	5.46E-02	1.75E-01
Richmond	VA	51	760	0.03	0.05	0.07	6.57E-04	6.02E-03	3.75E-03	1.21E-02
Sacramento	CA	06	067	0.02	0.04	0.06	5.43E-04	4.98E-03	3.10E-03	9.97E-03
Salem	MA	25	009	0.03	0.04	0.07	6.27E-04	5.75E-03	3.59E-03	1.15E-02
San Diego	CA	06	073	0.04	0.06	0.08	8.07E-04	7.39E-03	4.61E-03	1.48E-02
San Francisco	CA	06	075	0.04	0.06	0.09	8.69E-04	7.96E-03	4.96E-03	1.59E-02
San Juan	PR	72	127	0.30	0.46	0.69	6.62E-03	6.07E-02	3.78E-02	1.22E-01
Sandusky	OH	39	043	0.07	0.10	0.16	1.49E-03	1.37E-02	8.54E-03	2.74E-02

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	Total National Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	National CMV VOC Emissions (short tons) <sup>2</sup>	Local Port VOC Emissions (short tons)	75% Dist. Oil Used In Port <sup>3</sup>	Total VOCs Produced in Port (short tons)
Savannah	GA	13	051	17,598,389	2,422,595,044	0.73	30,873	224	75%	168
Searsport	ME	23	027	1,432,945	2,422,595,044	0.06	30,873	18	75%	14
Seattle	WA	53	033	23,546,789	2,422,595,044	0.97	30,873	300	75%	225
Silver Bay	MN	27	075	5,240,398	2,422,595,044	0.22	30,873	67	75%	50
South Louisiana, Port of	LA	22	009	189,814,564	2,422,595,044	7.84	30,873	2,419	75%	1,814
St. Clair	MI	26	099	5,426,565	2,422,595,044	0.22	30,873	69	75%	52
St. Louis	MO	29	510	30,161,905	2,422,595,044	1.25	30,873	384	75%	288
St. Paul	MN	27	163	4,755,765	2,422,595,044	0.20	30,873	61	75%	45
Stamford	CT	09	001	1,036,791	2,422,595,044	0.04	30,873	13	75%	10
Stockton	CA	06	077	1,142,608	2,422,595,044	0.05	30,873	15	75%	11
Stoneport	MI	26	141	7,989,550	2,422,595,044	0.33	30,873	102	75%	76
Tacoma	WA	53	053	21,490,783	2,422,595,044	0.89	30,873	274	75%	205
Taconite	MN	27	061	8,408,145	2,422,595,044	0.35	30,873	107	75%	80
Tampa	FL	12	057	49,292,651	2,422,595,044	2.03	30,873	628	75%	471
Texas City	TX	48	167	56,393,758	2,422,595,044	2.33	30,873	719	75%	539
Toledo	OH	39	095	13,031,631	2,422,595,044	0.54	30,873	166	75%	125
Tulsa, Port of Catoosa	OK	40	143	1,909,574	2,422,595,044	0.08	30,873	24	75%	18
Two Harbors	MN	27	075	10,661,655	2,422,595,044	0.44	30,873	136	75%	102
Valdez	AK	02	261	77,116,459	2,422,595,044	3.18	30,873	983	75%	737
Vancouver	WA	53	011	7,703,713	2,422,595,044	0.32	30,873	98	75%	74
Vicksburg	MS	28	149	4,728,437	2,422,595,044	0.20	30,873	60	75%	45
Victoria	TX	48	469	4,351,045	2,422,595,044	0.18	30,873	55	75%	42
Weodon Island	FL	12	103	1,300,587	2,422,595,044	0.05	30,873	17	75%	12
Wilmington	DE	10	003	4,323,864	2,422,595,044	0.18	30,873	55	75%	41
Wilmington	NC	37	129	7,581,853	2,422,595,044	0.31	30,873	97	75%	72

**References**

1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Downloaded from the following Internet site: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.

2: U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions from Compression Ignition Marine Engines*. EPA-420-R-98-017. Office of Mobile Sources, Engine Programs and Compliance Division. Ann Arbor, MI. 1998.

3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1998.

4: Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	National CMV PM <sub>10</sub> Emissions (short tons) <sup>2</sup>	Local Port PM <sub>10</sub> Emissions (short tons)	Total PM <sub>10</sub> Produced in Port (short tons)	Tons Acrolein (0.0035 acrolein/VOC) <sup>4</sup>	Tons Ethyl-benzene (0.0020 e-benzene/VOC) <sup>4</sup>	Tons n-Hexane (0.0055 n-hexane/VOC) <sup>4</sup>	Tons Propion-aldehyde (0.0061 propion-aldehyde/VOC) <sup>4</sup>
Savannah	GA	13	051	39,652	28,804	21,603	0.59	0.34	0.93	1.03
Searsport	ME	23	027	39,652	2,345	1,759	0.05	0.03	0.08	0.08
Seattle	WA	53	033	39,652	38,540	28,905	0.79	0.45	1.24	1.37
Silver Bay	MN	27	075	39,652	8,577	6,433	0.18	0.10	0.28	0.31
South Louisiana, Port of	LA	22	009	39,652	310,680	233,010	6.35	3.63	9.98	11.07
St. Clair	MI	26	099	39,652	8,882	6,661	0.18	0.10	0.29	0.32
St. Louis	MO	29	510	39,652	49,368	37,026	1.01	0.58	1.59	1.76
St. Paul	MN	27	163	39,652	7,784	5,838	0.16	0.09	0.25	0.28
Stamford	CT	09	001	39,652	1,697	1,273	0.03	0.02	0.05	0.06
Stockton	CA	06	077	39,652	1,870	1,403	0.04	0.02	0.06	0.07
Stoneport	MI	26	141	39,652	13,077	9,808	0.27	0.15	0.42	0.47
Tacoma	WA	53	053	39,652	35,175	26,381	0.72	0.41	1.13	1.25
Taconite	MN	27	061	39,652	13,762	10,322	0.28	0.16	0.44	0.49
Tampa	FL	12	057	39,652	80,680	60,510	1.65	0.94	2.59	2.87
Texas City	TX	48	167	39,652	92,303	69,227	1.89	1.08	2.96	3.29
Toledo	OH	39	095	39,652	21,330	15,997	0.44	0.25	0.69	0.76
Tulsa, Port of Catoosa	OK	40	143	39,652	3,126	2,344	0.06	0.04	0.10	0.11
Two Harbors	MN	27	075	39,652	17,451	13,088	0.36	0.20	0.56	0.62
Valdez	AK	02	261	39,652	126,221	94,666	2.58	1.47	4.05	4.50
Vancouver	WA	53	011	39,652	12,609	9,457	0.26	0.15	0.40	0.45
Vicksburg	MS	28	149	39,652	7,739	5,804	0.16	0.09	0.25	0.28
Victoria	TX	48	469	39,652	7,122	5,341	0.15	0.08	0.23	0.25
Weedon Island	FL	12	103	39,652	2,129	1,597	0.04	0.02	0.07	0.08
Wilmington	DE	10	003	39,652	7,077	5,308	0.14	0.08	0.23	0.25
Wilmington	NC	37	129	39,652	12,410	9,307	0.25	0.14	0.40	0.44

**References**

- 1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Downloaded from the following Internet site: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.
- 2: U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions from Compression Ignition Marine Engines*. EPA-420-R-98-017. Office of Mobile Sources, Engine Programs and Compliance Division. Ann Arbor, MI. 1998.
- 3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1998.
- 4: Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Distillate Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Tons Styrene (0.0021 styrene/VOC) <sup>4</sup>	Tons Toluene (0.0032 toluene/VOC) <sup>4</sup>	Tons Xylene (0.0048 xylene/VOC) <sup>4</sup>	Tons Arsenic (3.57E-07 arsenic/PM <sub>10</sub> ) <sup>4</sup>	Tons Chromium (3.27E-06 chromium/PM <sub>10</sub> ) <sup>4</sup>	Tons Manganese (2.04E-06 manganese/PM <sub>10</sub> ) <sup>4</sup>	Tons Nickel (6.55E-06 nickel/PM <sub>10</sub> ) <sup>4</sup>
Savannah	GA	13	051	0.35	0.54	0.81	7.71E-03	7.06E-02	4.41E-02	1.42E-01
Searsport	ME	23	027	0.03	0.04	0.07	6.28E-04	5.75E-03	3.59E-03	1.15E-02
Seattle	WA	53	033	0.47	0.72	1.08	1.03E-02	9.45E-02	5.90E-02	1.89E-01
Silver Bay	MN	27	075	0.11	0.16	0.24	2.30E-03	2.10E-02	1.31E-02	4.21E-02
South Louisiana, Port of	LA	22	009	3.81	5.81	8.71	8.32E-02	7.62E-01	4.75E-01	1.53E+00
St. Clair	MI	26	099	0.11	0.17	0.25	2.38E-03	2.18E-02	1.36E-02	4.36E-02
St. Louis	MO	29	510	0.61	0.92	1.38	1.32E-02	1.21E-01	7.55E-02	2.43E-01
St. Paul	MN	27	163	0.10	0.15	0.22	2.08E-03	1.91E-02	1.19E-02	3.82E-02
Stamford	CT	09	001	0.02	0.03	0.05	4.54E-04	4.16E-03	2.60E-03	8.34E-03
Stockton	CA	06	077	0.02	0.03	0.05	5.01E-04	4.59E-03	2.86E-03	9.19E-03
Stoneport	MI	26	141	0.16	0.24	0.37	3.50E-03	3.21E-02	2.00E-02	6.42E-02
Tacoma	WA	53	053	0.43	0.66	0.99	9.42E-03	8.63E-02	5.38E-02	1.73E-01
Taconite	MN	27	061	0.17	0.26	0.39	3.68E-03	3.38E-02	2.11E-02	6.76E-02
Tampa	FL	12	057	0.99	1.51	2.26	2.16E-02	1.98E-01	1.23E-01	3.96E-01
Texas City	TX	48	167	1.13	1.72	2.59	2.47E-02	2.26E-01	1.41E-01	4.53E-01
Toledo	OH	39	095	0.26	0.40	0.60	5.71E-03	5.23E-02	3.26E-02	1.05E-01
Tulsa, Port of Catoosa	OK	40	143	0.04	0.06	0.09	8.37E-04	7.67E-03	4.78E-03	1.54E-02
Two Harbors	MN	27	075	0.21	0.33	0.49	4.67E-03	4.28E-02	2.67E-02	8.57E-02
Valdez	AK	02	261	1.55	2.36	3.54	3.38E-02	3.10E-01	1.93E-01	6.20E-01
Vancouver	WA	53	011	0.15	0.24	0.35	3.38E-03	3.09E-02	1.93E-02	6.19E-02
Vicksburg	MS	28	149	0.09	0.14	0.22	2.07E-03	1.90E-02	1.18E-02	3.80E-02
Victoria	TX	48	469	0.09	0.13	0.20	1.91E-03	1.75E-02	1.09E-02	3.50E-02
Weedon Island	FL	12	103	0.03	0.04	0.06	5.70E-04	5.22E-03	3.26E-03	1.05E-02
Wilmington	DE	10	003	0.09	0.13	0.20	1.89E-03	1.74E-02	1.08E-02	3.48E-02
Wilmington	NC	37	129	0.15	0.23	0.35	3.32E-03	3.04E-02	1.90E-02	6.10E-02

**References**

1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Downloaded from the following Internet site:  
<http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.

2: U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions from Compression Ignition Marine Engines*. EPA-420-R-98-017. Office of Mobile Sources, Engine Programs and Compliance Division. Ann Arbor, MI. 1998.

3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1998.

4: Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

## **APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS**

## **Method:**

Port Residual Fuel Oil Emissions										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	National Total Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	Nat'l Residual Oil Sales (10 <sup>3</sup> gallons) <sup>2</sup>	Local Port Resid. Oil Sales (10 <sup>3</sup> gallons)	25% Resid. Oil Used In Port <sup>3</sup>	Total Resid. Oil Used in Port (10 <sup>3</sup> gallons)
Albany	NY	36	001	5,767,708	2,422,595,044	0.00238	5,701,233	13,573	25%	3,393
Alpena	MI	26	007	2,345,044	2,422,595,044	0.00097	5,701,233	5,519	25%	1,380
Anacortes	WA	53	057	13,843,669	2,422,595,044	0.00571	5,701,233	32,579	25%	8,145
Anchorage	AK	02	020	3,400,568	2,422,595,044	0.00140	5,701,233	8,003	25%	2,001
Ashtabula	OH	39	007	9,523,147	2,422,595,044	0.00393	5,701,233	22,411	25%	5,603
Baltimore	MD	24	510	43,552,356	2,422,595,044	0.01798	5,701,233	102,494	25%	25,624
Barbers Point, Oahu	HI	15	003	8,745,039	2,422,595,044	0.00361	5,701,233	20,580	25%	5,145
Baton Rouge	LA	22	033	81,009,253	2,422,595,044	0.03344	5,701,233	190,644	25%	47,661
Beaumont	TX	48	245	35,705,109	2,422,595,044	0.01474	5,701,233	84,027	25%	21,007
Bellingham	WA	53	073	1,419,257	2,422,595,044	0.00059	5,701,233	3,340	25%	835
Biloxi	MS	28	047	2,266,417	2,422,595,044	0.00094	5,701,233	5,334	25%	1,333
Boston	MA	25	025	20,103,978	2,422,595,044	0.00830	5,701,233	47,312	25%	11,828
Bridgeport	CT	09	001	4,862,015	2,422,595,044	0.00201	5,701,233	11,442	25%	2,861
Brownsville	TX	48	061	2,401,280	2,422,595,044	0.00099	5,701,233	5,651	25%	1,413
Brunswick	GA	13	127	2,063,388	2,422,595,044	0.00085	5,701,233	4,856	25%	1,214
Bucksport	ME	23	009	1,029,135	2,422,595,044	0.00042	5,701,233	2,422	25%	605
Buffalo	NY	36	029	1,864,256	2,422,595,044	0.00077	5,701,233	4,387	25%	1,097
Buffington	IN	18	089	1,242,522	2,422,595,044	0.00051	5,701,233	2,924	25%	731
Burns Waterway Harbor	IN	18	127	9,847,873	2,422,595,044	0.00407	5,701,233	23,176	25%	5,794
Calcite	MI	26	141	8,669,387	2,422,595,044	0.00358	5,701,233	20,402	25%	5,101
Camden-Gloucester	NJ	34	007	5,765,260	2,422,595,044	0.00238	5,701,233	13,568	25%	3,392
Charleston	SC	45	019	11,082,558	2,422,595,044	0.00457	5,701,233	26,081	25%	6,520
Charlevoix	MI	26	029	1,665,865	2,422,595,044	0.00069	5,701,233	3,920	25%	980
Chattanooga	TN	47	065	2,717,613	2,422,595,044	0.00112	5,701,233	6,396	25%	1,599
Chester	PA	42	045	2,402,491	2,422,595,044	0.00099	5,701,233	5,654	25%	1,413
Chicago	IL	17	031	27,886,169	2,422,595,044	0.01151	5,701,233	65,626	25%	16,407
Cincinnati	OH	39	061	12,803,247	2,422,595,044	0.00528	5,701,233	30,131	25%	7,533
Cleveland	OH	39	035	16,720,837	2,422,595,044	0.00690	5,701,233	39,350	25%	9,838
Conneaut	OH	39	007	5,714,402	2,422,595,044	0.00236	5,701,233	13,448	25%	3,362
Coos Bay	OR	41	011	3,322,218	2,422,595,044	0.00137	5,701,233	7,818	25%	1,955
Corpus Christi	TX	48	355	80,460,088	2,422,595,044	0.03321	5,701,233	189,351	25%	47,338
Detroit	MI	26	163	18,603,745	2,422,595,044	0.00768	5,701,233	43,781	25%	10,945
Drummond Island	MI	26	033	1,681,900	2,422,595,044	0.00069	5,701,233	3,958	25%	990
Duluth	MN	27	137	41,398,293	2,422,595,044	0.01709	5,701,233	97,425	25%	24,356
Erie	PA	42	049	1,433,725	2,422,595,044	0.00059	5,701,233	3,374	25%	844
Escanaba	MI	26	041	9,253,402	2,422,595,044	0.00382	5,701,233	21,777	25%	5,444
Everett	WA	53	061	4,007,238	2,422,595,044	0.00165	5,701,233	9,430	25%	2,358
Fairport Harbor	OH	39	085	2,770,276	2,422,595,044	0.00114	5,701,233	6,519	25%	1,630
Fall River	MA	25	005	3,180,225	2,422,595,044	0.00131	5,701,233	7,484	25%	1,871
Freeport	TX	48	039	24,570,954	2,422,595,044	0.01014	5,701,233	57,824	25%	14,456

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Residual Fuel Oil Emissions (Continued)							
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Acet-aldehyde Emission Factor: 2.45E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Benzene Emission Factor: 1.05E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Form-aldehyde Emission Factor: 1.68E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	POM as 7-PAH Emission Factor: 5.81E-09 tons/10 <sup>3</sup> gallon <sup>5</sup>
Albany	NY	36	001	8.31E-03	3.56E-04	5.70E-02	1.97E-05
Alpena	MI	26	007	3.38E-03	1.45E-04	2.32E-02	8.02E-06
Anacortes	WA	53	057	2.00E-02	8.55E-04	1.37E-01	4.73E-05
Anchorage	AK	02	020	4.90E-03	2.10E-04	3.36E-02	1.16E-05
Ashtabula	OH	39	007	1.37E-02	5.88E-04	9.41E-02	3.26E-05
Baltimore	MD	24	510	6.28E-02	2.69E-03	4.30E-01	1.49E-04
Barbers Point, Oahu	HI	15	003	1.26E-02	5.40E-04	8.64E-02	2.99E-05
Baton Rouge	LA	22	033	1.17E-01	5.00E-03	8.01E-01	2.77E-04
Beaumont	TX	48	245	5.15E-02	2.21E-03	3.53E-01	1.22E-04
Bellingham	WA	53	073	2.05E-03	8.77E-05	1.40E-02	4.85E-06
Biloxi	MS	28	047	3.27E-03	1.40E-04	2.24E-02	7.75E-06
Boston	MA	25	025	2.90E-02	1.24E-03	1.99E-01	6.87E-05
Bridgeport	CT	09	001	7.01E-03	3.00E-04	4.81E-02	1.66E-05
Brownsville	TX	48	061	3.46E-03	1.48E-04	2.37E-02	8.21E-06
Brunswick	GA	13	127	2.97E-03	1.27E-04	2.04E-02	7.05E-06
Bucksport	ME	23	009	1.48E-03	6.36E-05	1.02E-02	3.52E-06
Buffalo	NY	36	029	2.69E-03	1.15E-04	1.84E-02	6.37E-06
Buffington	IN	18	089	1.79E-03	7.68E-05	1.23E-02	4.25E-06
Burns Waterway Harbor	IN	18	127	1.42E-02	6.08E-04	9.73E-02	3.37E-05
Calcite	MI	26	141	1.25E-02	5.36E-04	8.57E-02	2.96E-05
Camden-Gloucester	NJ	34	007	8.31E-03	3.56E-04	5.70E-02	1.97E-05
Charleston	SC	45	019	1.60E-02	6.85E-04	1.10E-01	3.79E-05
Charlevoix	MI	26	029	2.40E-03	1.03E-04	1.65E-02	5.69E-06
Chattanooga	TN	47	065	3.92E-03	1.68E-04	2.69E-02	9.29E-06
Chester	PA	42	045	3.46E-03	1.48E-04	2.37E-02	8.21E-06
Chicago	IL	17	031	4.02E-02	1.72E-03	2.76E-01	9.53E-05
Cincinnati	OH	39	061	1.85E-02	7.91E-04	1.27E-01	4.38E-05
Cleveland	OH	39	035	2.41E-02	1.03E-03	1.65E-01	5.72E-05
Conneaut	OH	39	007	8.24E-03	3.53E-04	5.65E-02	1.95E-05
Coos Bay	OR	41	011	4.79E-03	2.05E-04	3.28E-02	1.14E-05
Corpus Christi	TX	48	355	1.16E-01	4.97E-03	7.95E-01	2.75E-04
Detroit	MI	26	163	2.68E-02	1.15E-03	1.84E-01	6.36E-05
Drummond Island	MI	26	033	2.42E-03	1.04E-04	1.66E-02	5.75E-06
Duluth	MN	27	137	5.97E-02	2.56E-03	4.09E-01	1.42E-04
Erie	PA	42	049	2.07E-03	8.86E-05	1.42E-02	4.90E-06
Escanaba	MI	26	041	1.33E-02	5.72E-04	9.15E-02	3.16E-05
Everett	WA	53	061	5.78E-03	2.48E-04	3.96E-02	1.37E-05
Fairport Harbor	OH	39	085	3.99E-03	1.71E-04	2.74E-02	9.47E-06
Fall River	MA	25	005	4.58E-03	1.96E-04	3.14E-02	1.09E-05
Freeport	TX	48	039	3.54E-02	1.52E-03	2.43E-01	8.40E-05

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## Method:

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Cadmium Emission Factor: 1.96E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Chromium Emission Factor: 4.20E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Lead Emission Factor: 7.70E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Manganese Emission Factor: 1.47E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Mercury Emission Factor: 5.67E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Nickel Emission Factor: 4.20E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Selenium Emission Factor: 3.43E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Albany	NY	36	001	6.65E-04	1.43E-03	2.61E-03	4.99E-03	1.92E-04	1.43E-01	1.16E-03
Alpena	MI	26	007	2.70E-04	5.79E-04	1.06E-03	2.03E-03	7.82E-05	5.79E-02	4.73E-04
Anacortes	WA	53	057	1.60E-03	3.42E-03	6.27E-03	1.20E-02	4.62E-04	3.42E-01	2.79E-03
Anchorage	AK	02	020	3.92E-04	8.40E-04	1.54E-03	2.94E-03	1.13E-04	8.40E-02	6.86E-04
Ashtabula	OH	39	007	1.10E-03	2.35E-03	4.31E-03	8.24E-03	3.18E-04	2.35E-01	1.92E-03
Baltimore	MD	24	510	5.02E-03	1.08E-02	1.97E-02	3.77E-02	1.45E-03	1.08E+00	8.79E-03
Barbers Point, Oahu	HI	15	003	1.01E-03	2.16E-03	3.96E-03	7.56E-03	2.92E-04	2.16E-01	1.76E-03
Baton Rouge	LA	22	033	9.34E-03	2.00E-02	3.67E-02	7.01E-02	2.70E-03	2.00E+00	1.63E-02
Beaumont	TX	48	245	4.12E-03	8.82E-03	1.62E-02	3.09E-02	1.19E-03	8.82E-01	7.21E-03
Bellingham	WA	53	073	1.64E-04	3.51E-04	6.43E-04	1.23E-03	4.73E-05	3.51E-02	2.86E-04
Biloxi	MS	28	047	2.61E-04	5.60E-04	1.03E-03	1.96E-03	7.56E-05	5.60E-02	4.57E-04
Boston	MA	25	025	2.32E-03	4.97E-03	9.11E-03	1.74E-02	6.71E-04	4.97E-01	4.06E-03
Bridgeport	CT	09	001	5.61E-04	1.20E-03	2.20E-03	4.20E-03	1.62E-04	1.20E-01	9.81E-04
Brownsville	TX	48	061	2.77E-04	5.93E-04	1.09E-03	2.08E-03	8.01E-05	5.93E-02	4.85E-04
Brunswick	GA	13	127	2.38E-04	5.10E-04	9.35E-04	1.78E-03	6.88E-05	5.10E-02	4.16E-04
Bucksport	ME	23	009	1.19E-04	2.54E-04	4.66E-04	8.90E-04	3.43E-05	2.54E-02	2.08E-04
Buffalo	NY	36	029	2.15E-04	4.61E-04	8.45E-04	1.61E-03	6.22E-05	4.61E-02	3.76E-04
Buffington	IN	18	089	1.43E-04	3.07E-04	5.63E-04	1.07E-03	4.14E-05	3.07E-02	2.51E-04
Burns Waterway Harbor	IN	18	127	1.14E-03	2.43E-03	4.46E-03	8.52E-03	3.29E-04	2.43E-01	1.99E-03
Calcite	MI	26	141	1.00E-03	2.14E-03	3.93E-03	7.50E-03	2.89E-04	2.14E-01	1.75E-03
Camden-Gloucester	NJ	34	007	6.65E-04	1.42E-03	2.61E-03	4.99E-03	1.92E-04	1.42E-01	1.16E-03
Charleston	SC	45	019	1.28E-03	2.74E-03	5.02E-03	9.58E-03	3.70E-04	2.74E-01	2.24E-03
Charlevoix	MI	26	029	1.92E-04	4.12E-04	7.55E-04	1.44E-03	5.56E-05	4.12E-02	3.36E-04
Chattanooga	TN	47	065	3.13E-04	6.72E-04	1.23E-03	2.35E-03	9.07E-05	6.72E-02	5.48E-04
Chester	PA	42	045	2.77E-04	5.94E-04	1.09E-03	2.08E-03	8.01E-05	5.94E-02	4.85E-04
Chicago	IL	17	031	3.22E-03	6.89E-03	1.26E-02	2.41E-02	9.30E-04	6.89E-01	5.63E-03
Cincinnati	OH	39	061	1.48E-03	3.16E-03	5.80E-03	1.11E-02	4.27E-04	3.16E-01	2.58E-03
Cleveland	OH	39	035	1.93E-03	4.13E-03	7.57E-03	1.45E-02	5.58E-04	4.13E-01	3.37E-03
Conneaut	OH	39	007	6.59E-04	1.41E-03	2.59E-03	4.94E-03	1.91E-04	1.41E-01	1.15E-03
Coos Bay	OR	41	011	3.83E-04	8.21E-04	1.51E-03	2.87E-03	1.11E-04	8.21E-02	6.70E-04
Corpus Christi	TX	48	355	9.28E-03	1.99E-02	3.65E-02	6.96E-02	2.68E-03	1.99E+00	1.62E-02
Detroit	MI	26	163	2.15E-03	4.60E-03	8.43E-03	1.61E-02	6.21E-04	4.60E-01	3.75E-03
Drummond Island	MI	26	033	1.94E-04	4.16E-04	7.62E-04	1.45E-03	5.61E-05	4.16E-02	3.39E-04
Duluth	MN	27	137	4.77E-03	1.02E-02	1.88E-02	3.58E-02	1.38E-03	1.02E+00	8.35E-03
Erie	PA	42	049	1.65E-04	3.54E-04	6.50E-04	1.24E-03	4.78E-05	3.54E-02	2.89E-04
Escanaba	MI	26	041	1.07E-03	2.29E-03	4.19E-03	8.00E-03	3.09E-04	2.29E-01	1.87E-03
Everett	WA	53	061	4.62E-04	9.90E-04	1.82E-03	3.47E-03	1.34E-04	9.90E-02	8.09E-04
Fairport Harbor	OH	39	085	3.19E-04	6.85E-04	1.25E-03	2.40E-03	9.24E-05	6.85E-02	5.59E-04
Fall River	MA	25	005	3.67E-04	7.86E-04	1.44E-03	2.75E-03	1.06E-04	7.86E-02	6.42E-04
Freeport	TX	48	039	2.83E-03	6.07E-03	1.11E-02	2.13E-02	8.20E-04	6.07E-01	4.96E-03

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

## **Method:**

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	National Total Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	Nat'l Residual Oil Sales (10 <sup>3</sup> gallons) <sup>2</sup>	Local Port Resid. Oil Sales (10 <sup>3</sup> gallons)	25% Resid. Oil Used In Port <sup>3</sup>	Total Resid. Oil Used in Port (10 <sup>3</sup> gallons)
Galveston	TX	48	167	11,640,754	2,422,595,044	0.00481	5,701,233	27,395	25%	6,849
Gary	IN	18	089	8,882,164	2,422,595,044	0.00367	5,701,233	20,903	25%	5,226
Georgetown	SC	45	043	1,379,408	2,422,595,044	0.00057	5,701,233	3,246	25%	812
Grays Harbor	WA	53	027	1,990,077	2,422,595,044	0.00082	5,701,233	4,683	25%	1,171
Green Bay	WI	55	009	2,176,192	2,422,595,044	0.00090	5,701,233	5,121	25%	1,280
Greenville	MS	28	151	2,543,382	2,422,595,044	0.00105	5,701,233	5,985	25%	1,496
Gulfport	MS	28	047	2,123,671	2,422,595,044	0.00088	5,701,233	4,998	25%	1,249
Guntersville	AL	01	095	2,597,760	2,422,595,044	0.00107	5,701,233	6,113	25%	1,528
Helena	AR	05	107	2,285,638	2,422,595,044	0.00094	5,701,233	5,379	25%	1,345
Hempstead	NY	36	059	1,329,385	2,422,595,044	0.00055	5,701,233	3,129	25%	782
Hilo	HI	15	001	1,441,507	2,422,595,044	0.00060	5,701,233	3,392	25%	848
Honolulu	HI	15	003	12,010,003	2,422,595,044	0.00496	5,701,233	28,264	25%	7,066
Hopewell	VA	51	670	1,394,904	2,422,595,044	0.00058	5,701,233	3,283	25%	821
Houston	TX	48	201	148,182,876	2,422,595,044	0.06117	5,701,233	348,727	25%	87,182
Humboldt	CA	06	023	1,196,796	2,422,595,044	0.00049	5,701,233	2,816	25%	704
Huntington	WV	54	011	27,478,215	2,422,595,044	0.01134	5,701,233	64,666	25%	16,167
Huron	OH	39	043	1,003,830	2,422,595,044	0.00041	5,701,233	2,362	25%	591
Indiana Harbor	IN	18	089	16,892,858	2,422,595,044	0.00697	5,701,233	39,755	25%	9,939
Jacksonville	FL	12	031	16,736,773	2,422,595,044	0.00691	5,701,233	39,388	25%	9,847
Kahului, Maui	HI	15	009	2,827,806	2,422,595,044	0.00117	5,701,233	6,655	25%	1,664
Kalama	WA	53	015	8,222,919	2,422,595,044	0.00339	5,701,233	19,351	25%	4,838
Kansas City	MO	29	095	3,009,981	2,422,595,044	0.00124	5,701,233	7,084	25%	1,771
Ketchikan	AK	02	130	1,340,609	2,422,595,044	0.00055	5,701,233	3,155	25%	789
Lake Charles	LA	22	019	49,096,325	2,422,595,044	0.02027	5,701,233	115,541	25%	28,885
Long Beach	CA	06	037	58,395,243	2,422,595,044	0.02410	5,701,233	137,425	25%	34,356
Longview	WA	53	015	5,162,634	2,422,595,044	0.00213	5,701,233	12,150	25%	3,037
Lorain	OH	39	093	15,977,949	2,422,595,044	0.00660	5,701,233	37,602	25%	9,400
Los Angeles	CA	06	037	45,689,232	2,422,595,044	0.01886	5,701,233	107,523	25%	26,881
Louisville	KY	21	111	8,779,342	2,422,595,044	0.00362	5,701,233	20,661	25%	5,165
Ludington	MI	26	105	1,236,834	2,422,595,044	0.00051	5,701,233	2,911	25%	728
Marblehead	OH	39	123	2,816,540	2,422,595,044	0.00116	5,701,233	6,628	25%	1,657
Marcus Hook	PA	42	045	12,365,946	2,422,595,044	0.00510	5,701,233	29,101	25%	7,275
Marine City	MI	26	147	4,116,212	2,422,595,044	0.00170	5,701,233	9,687	25%	2,422
Marquette	MI	26	103	1,598,125	2,422,595,044	0.00066	5,701,233	3,761	25%	940
Marysville	MI	26	147	1,067,783	2,422,595,044	0.00044	5,701,233	2,513	25%	628
Matagorda Ship Channel	TX	48	321	9,151,450	2,422,595,044	0.00378	5,701,233	21,537	25%	5,384
Memphis	TN	47	157	17,299,836	2,422,595,044	0.00714	5,701,233	40,713	25%	10,178
Miami	FL	12	025	5,719,107	2,422,595,044	0.00236	5,701,233	13,459	25%	3,365
Milwaukee	WI	55	079	2,858,231	2,422,595,044	0.00118	5,701,233	6,726	25%	1,682
Minneapolis	MN	27	053	1,567,477	2,422,595,044	0.00065	5,701,233	3,689	25%	922
Mobile	AL	01	097	50,863,944	2,422,595,044	0.02100	5,701,233	119,701	25%	29,925
Monroe	MI	26	115	1,794,335	2,422,595,044	0.00074	5,701,233	4,223	25%	1,056

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)									
Port Name <sup>1</sup>	FIPS State Code	FIPS County Code	Acet-aldehyde Emission Factor: 2.45E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Benzene Emission Factor: 1.05E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Form-aldehyde Emission Factor: 1.68E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	POM as 7-PAH Emission Factor: 5.81E-09 tons/10 <sup>3</sup> gallon <sup>5</sup>	POM as 16-PAH Emission Factor: 5.88E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Arsenic Emission Factor: 6.58E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Beryllium Emission Factor: 1.40E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Galveston	TX 48	167	1.68E-02	7.19E-04	1.15E-01	3.98E-05	4.03E-03	4.51E-03	9.59E-05
Gary	IN 18	089	1.28E-02	5.49E-04	8.78E-02	3.04E-05	3.07E-03	3.44E-03	7.32E-05
Georgetown	SC 45	043	1.99E-03	8.52E-05	1.36E-02	4.72E-06	4.77E-04	5.34E-04	1.14E-05
Grays Harbor	WA 53	027	2.87E-03	1.23E-04	1.97E-02	6.80E-06	6.88E-04	7.70E-04	1.64E-05
Green Bay	WI 55	009	3.14E-03	1.34E-04	2.15E-02	7.44E-06	7.53E-04	8.42E-04	1.79E-05
Greenville	MS 28	151	3.67E-03	1.57E-04	2.51E-02	8.69E-06	8.80E-04	9.85E-04	2.09E-05
Gulfport	MS 28	047	3.06E-03	1.31E-04	2.10E-02	7.26E-06	7.35E-04	8.22E-04	1.75E-05
Guntersville	AL 01	095	3.74E-03	1.60E-04	2.57E-02	8.88E-06	8.99E-04	1.01E-03	2.14E-05
Helena	AR 05	107	3.29E-03	1.41E-04	2.26E-02	7.81E-06	7.91E-04	8.85E-04	1.88E-05
Hempstead	NY 36	059	1.92E-03	8.21E-05	1.31E-02	4.54E-06	4.60E-04	5.15E-04	1.09E-05
Hilo	HI 15	001	2.08E-03	8.91E-05	1.42E-02	4.93E-06	4.99E-04	5.58E-04	1.19E-05
Honolulu	HI 15	003	1.73E-02	7.42E-04	1.19E-01	4.11E-05	4.15E-03	4.65E-03	9.89E-05
Hopewell	VA 51	670	2.01E-03	8.62E-05	1.38E-02	4.77E-06	4.83E-04	5.40E-04	1.15E-05
Houston	TX 48	201	2.14E-01	9.15E-03	1.46E+00	5.07E-04	5.13E-02	5.74E-02	1.22E-03
Humboldt	CA 06	023	1.73E-03	7.39E-05	1.18E-02	4.09E-06	4.14E-04	4.63E-04	9.86E-06
Huntington	WV 54	011	3.96E-02	1.70E-03	2.72E-01	9.39E-05	9.51E-03	1.06E-02	2.26E-04
Huron	OH 39	043	1.45E-03	6.20E-05	9.92E-03	3.43E-06	3.47E-04	3.89E-04	8.27E-06
Indiana Harbor	IN 18	089	2.43E-02	1.04E-03	1.67E-01	5.77E-05	5.84E-03	6.54E-03	1.39E-04
Jacksonville	FL 12	031	2.41E-02	1.03E-03	1.65E-01	5.72E-05	5.79E-03	6.48E-03	1.38E-04
Kahului, Maui	HI 15	009	4.08E-03	1.75E-04	2.80E-02	9.67E-06	9.78E-04	1.09E-03	2.33E-05
Kalama	WA 53	015	1.19E-02	5.08E-04	8.13E-02	2.81E-05	2.84E-03	3.18E-03	6.77E-05
Kansas City	MO 29	095	4.34E-03	1.86E-04	2.98E-02	1.03E-05	1.04E-03	1.17E-03	2.48E-05
Ketchikan	AK 02	130	1.93E-03	8.28E-05	1.33E-02	4.58E-06	4.64E-04	5.19E-04	1.10E-05
Lake Charles	LA 22	019	7.08E-02	3.03E-03	4.85E-01	1.68E-04	1.70E-02	1.90E-02	4.04E-04
Long Beach	CA 06	037	8.42E-02	3.61E-03	5.77E-01	2.00E-04	2.02E-02	2.26E-02	4.81E-04
Longview	WA 53	015	7.44E-03	3.19E-04	5.10E-02	1.76E-05	1.79E-03	2.00E-03	4.25E-05
Lorain	OH 39	093	2.30E-02	9.87E-04	1.58E-01	5.46E-05	5.53E-03	6.19E-03	1.32E-04
Los Angeles	CA 06	037	6.59E-02	2.82E-03	4.52E-01	1.56E-04	1.58E-02	1.77E-02	3.76E-04
Louisville	KY 21	111	1.27E-02	5.42E-04	8.68E-02	3.00E-05	3.04E-03	3.40E-03	7.23E-05
Ludington	MI 26	105	1.78E-03	7.64E-05	1.22E-02	4.23E-06	4.28E-04	4.79E-04	1.02E-05
Marblehead	OH 39	123	4.06E-03	1.74E-04	2.78E-02	9.63E-06	9.74E-04	1.09E-03	2.32E-05
Marcus Hook	PA 42	045	1.78E-02	7.64E-04	1.22E-01	4.23E-05	4.28E-03	4.79E-03	1.02E-04
Marine City	MI 26	147	5.93E-03	2.54E-04	4.07E-02	1.41E-05	1.42E-03	1.59E-03	3.39E-05
Marquette	MI 26	103	2.30E-03	9.87E-05	1.58E-02	5.46E-06	5.53E-04	6.19E-04	1.32E-05
Marysville	MI 26	147	1.54E-03	6.60E-05	1.06E-02	3.65E-06	3.69E-04	4.13E-04	8.80E-06
Matagorda Ship Channel	TX 48	321	1.32E-02	5.65E-04	9.05E-02	3.13E-05	3.17E-03	3.54E-03	7.54E-05
Memphis	TN 47	157	2.49E-02	1.07E-03	1.71E-01	5.91E-05	5.98E-03	6.70E-03	1.42E-04
Miami	FL 12	025	8.24E-03	3.53E-04	5.65E-02	1.95E-05	1.98E-03	2.21E-03	4.71E-05
Milwaukee	WI 55	079	4.12E-03	1.77E-04	2.83E-02	9.77E-06	9.89E-04	1.11E-03	2.35E-05
Minneapolis	MN 27	053	2.26E-03	9.68E-05	1.55E-02	5.36E-06	5.42E-04	6.07E-04	1.29E-05
Mobile	AL 01	097	7.33E-02	3.14E-03	5.03E-01	1.74E-04	1.76E-02	1.97E-02	4.19E-04
Monroe	MI 26	115	2.59E-03	1.11E-04	1.77E-02	6.13E-06	6.21E-04	6.95E-04	1.48E-05

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)				Cadmium Emission Factor: 1.96E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Chromium Emission Factor: 4.20E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Lead Emission Factor: 7.70E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Manganese Emission Factor: 1.47E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Mercury Emission Factor: 5.67E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Nickel Emission Factor: 4.20E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Selenium Emission Factor: 3.43E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Port Name <sup>1</sup>	St.	FIPs State Code	FIPs County Code							
Galveston	TX	48	167	1.34E-03	2.88E-03	5.27E-03	1.01E-02	3.88E-04	2.88E-01	2.35E-03
Gary	IN	18	089	1.02E-03	2.19E-03	4.02E-03	7.68E-03	2.96E-04	2.19E-01	1.79E-03
Georgetown	SC	45	043	1.59E-04	3.41E-04	6.25E-04	1.19E-03	4.60E-05	3.41E-02	2.78E-04
Grays Harbor	WA	53	027	2.29E-04	4.92E-04	9.02E-04	1.72E-03	6.64E-05	4.92E-02	4.02E-04
Green Bay	WI	55	009	2.51E-04	5.38E-04	9.86E-04	1.88E-03	7.26E-05	5.38E-02	4.39E-04
Greenville	MS	28	151	2.93E-04	6.28E-04	1.15E-03	2.20E-03	8.48E-05	6.28E-02	5.13E-04
Gulfport	MS	28	047	2.45E-04	5.25E-04	9.62E-04	1.84E-03	7.08E-05	5.25E-02	4.29E-04
Guntersville	AL	01	095	3.00E-04	6.42E-04	1.18E-03	2.25E-03	8.67E-05	6.42E-02	5.24E-04
Helena	AR	05	107	2.64E-04	5.65E-04	1.04E-03	1.98E-03	7.62E-05	5.65E-02	4.61E-04
Hempstead	NY	36	059	1.53E-04	3.28E-04	6.02E-04	1.15E-03	4.43E-05	3.28E-02	2.68E-04
Hilo	HI	15	001	1.66E-04	3.56E-04	6.53E-04	1.25E-03	4.81E-05	3.56E-02	2.91E-04
Honolulu	HI	15	003	1.38E-03	2.97E-03	5.44E-03	1.04E-02	4.01E-04	2.97E-01	2.42E-03
Hopewell	VA	51	670	1.61E-04	3.45E-04	6.32E-04	1.21E-03	4.65E-05	3.45E-02	2.81E-04
Houston	TX	48	201	1.71E-02	3.66E-02	6.71E-02	1.28E-01	4.94E-03	3.66E+00	2.99E-02
Humboldt	CA	06	023	1.38E-04	2.96E-04	5.42E-04	1.04E-03	3.99E-05	2.96E-02	2.42E-04
Huntington	WV	54	011	3.17E-03	6.79E-03	1.24E-02	2.38E-02	9.17E-04	6.79E-01	5.55E-03
Huron	OH	39	043	1.16E-04	2.48E-04	4.55E-04	8.68E-04	3.35E-05	2.48E-02	2.03E-04
Indiana Harbor	IN	18	089	1.95E-03	4.17E-03	7.65E-03	1.46E-02	5.64E-04	4.17E-01	3.41E-03
Jacksonville	FL	12	031	1.93E-03	4.14E-03	7.58E-03	1.45E-02	5.58E-04	4.14E-01	3.38E-03
Kahului, Maui	HI	15	009	3.26E-04	6.99E-04	1.28E-03	2.45E-03	9.43E-05	6.99E-02	5.71E-04
Kalama	WA	53	015	9.48E-04	2.03E-03	3.73E-03	7.11E-03	2.74E-04	2.03E-01	1.66E-03
Kansas City	MO	29	095	3.47E-04	7.44E-04	1.36E-03	2.60E-03	1.00E-04	7.44E-02	6.07E-04
Ketchikan	AK	02	130	1.55E-04	3.31E-04	6.07E-04	1.16E-03	4.47E-05	3.31E-02	2.71E-04
Lake Charles	LA	22	019	5.66E-03	1.21E-02	2.22E-02	4.25E-02	1.64E-03	1.21E+00	9.91E-03
Long Beach	CA	06	037	6.73E-03	1.44E-02	2.65E-02	5.05E-02	1.95E-03	1.44E+00	1.18E-02
Longview	WA	53	015	5.95E-04	1.28E-03	2.34E-03	4.46E-03	1.72E-04	1.28E-01	1.04E-03
Lorain	OH	39	093	1.84E-03	3.95E-03	7.24E-03	1.38E-02	5.33E-04	3.95E-01	3.22E-03
Los Angeles	CA	06	037	5.27E-03	1.13E-02	2.07E-02	3.95E-02	1.52E-03	1.13E+00	9.22E-03
Louisville	KY	21	111	1.01E-03	2.17E-03	3.98E-03	7.59E-03	2.93E-04	2.17E-01	1.77E-03
Ludington	MI	26	105	1.43E-04	3.06E-04	5.60E-04	1.07E-03	4.13E-05	3.06E-02	2.50E-04
Marblehead	OH	39	123	3.25E-04	6.96E-04	1.28E-03	2.44E-03	9.40E-05	6.96E-02	5.68E-04
Marcus Hook	PA	42	045	1.43E-03	3.06E-03	5.60E-03	1.07E-02	4.13E-04	3.06E-01	2.50E-03
Marine City	MI	26	147	4.75E-04	1.02E-03	1.86E-03	3.56E-03	1.37E-04	1.02E-01	8.31E-04
Marquette	MI	26	103	1.84E-04	3.95E-04	7.24E-04	1.38E-03	5.33E-05	3.95E-02	3.23E-04
Marysville	MI	26	147	1.23E-04	2.64E-04	4.84E-04	9.23E-04	3.56E-05	2.64E-02	2.15E-04
Matagorda Ship Channel	TX	48	321	1.06E-03	2.26E-03	4.15E-03	7.91E-03	3.05E-04	2.26E-01	1.85E-03
Memphis	TN	47	157	1.99E-03	4.27E-03	7.84E-03	1.50E-02	5.77E-04	4.27E-01	3.49E-03
Miami	FL	12	025	6.59E-04	1.41E-03	2.59E-03	4.95E-03	1.91E-04	1.41E-01	1.15E-03
Milwaukee	WI	55	079	3.30E-04	7.06E-04	1.29E-03	2.47E-03	9.53E-05	7.06E-02	5.77E-04
Minneapolis	MN	27	053	1.81E-04	3.87E-04	7.10E-04	1.36E-03	5.23E-05	3.87E-02	3.16E-04
Mobile	AL	01	097	5.87E-03	1.26E-02	2.30E-02	4.40E-02	1.70E-03	1.26E+00	1.03E-02
Monroe	MI	26	115	2.07E-04	4.43E-04	8.13E-04	1.55E-03	5.99E-05	4.43E-02	3.62E-04

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	National Total Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	Nat'l Residual Oil Sales (10 <sup>3</sup> gallons) <sup>2</sup>	Local Port Resid. Oil Sales (10 <sup>3</sup> gallons)	25% Resid. Oil Used In Port <sup>3</sup>	Total Resid. Oil Used in Port (10 <sup>3</sup> gallons)
Morehead City	NC	37	031	5,540,766	2,422,595,044	0.00229	5,701,233	13,039	25%	3,260
Mount Vernon	IN	18	129	6,985,531	2,422,595,044	0.00288	5,701,233	16,439	25%	4,110
Muskegon	MI	26	121	2,172,075	2,422,595,044	0.00090	5,701,233	5,112	25%	1,278
Nashville	TN	47	037	3,777,854	2,422,595,044	0.00156	5,701,233	8,891	25%	2,223
Nawiliwili, Kauai	HI	15	007	1,203,276	2,422,595,044	0.00050	5,701,233	2,832	25%	708
New Castle	DE	10	003	9,377,080	2,422,595,044	0.00387	5,701,233	22,068	25%	5,517
New Haven	CT	09	009	8,838,093	2,422,595,044	0.00365	5,701,233	20,799	25%	5,200
New Orleans	LA	22	071	83,726,470	2,422,595,044	0.03456	5,701,233	197,038	25%	49,260
New York	NY	36	065	131,601,244	2,422,595,044	0.05432	5,701,233	309,705	25%	77,426
Newport News	VA	51	700	24,787,261	2,422,595,044	0.01023	5,701,233	58,333	25%	14,583
Nikishka	AK	02	290	5,049,883	2,422,595,044	0.00208	5,701,233	11,884	25%	2,971
Norfolk Harbor	VA	51	710	49,260,972	2,422,595,044	0.02033	5,701,233	115,929	25%	28,982
Oakland	CA	06	001	11,229,862	2,422,595,044	0.00464	5,701,233	26,428	25%	6,607
Olympia	WA	53	067	1,893,029	2,422,595,044	0.00078	5,701,233	4,455	25%	1,114
Palm Beach	FL	12	099	2,293,615	2,422,595,044	0.00095	5,701,233	5,398	25%	1,349
Panama City	FL	12	005	3,123,941	2,422,595,044	0.00129	5,701,233	7,352	25%	1,838
Pascagoula	MS	28	059	29,342,671	2,422,595,044	0.01211	5,701,233	69,054	25%	17,263
Paulsboro	NJ	34	015	25,038,524	2,422,595,044	0.01034	5,701,233	58,925	25%	14,731
Pensacola	FL	12	033	1,378,971	2,422,595,044	0.00057	5,701,233	3,245	25%	811
Philadelphia	PA	42	101	41,882,200	2,422,595,044	0.01729	5,701,233	98,564	25%	24,641
Pittsburgh	PA	42	003	50,874,367	2,422,595,044	0.02100	5,701,233	119,726	25%	29,931
Plaquemines, Port of	LA	22	047	66,910,237	2,422,595,044	0.02762	5,701,233	157,464	25%	39,366
Port Angeles	WA	53	009	2,780,081	2,422,595,044	0.00115	5,701,233	6,543	25%	1,636
Port Arthur	TX	48	245	37,157,786	2,422,595,044	0.01534	5,701,233	87,446	25%	21,861
Port Canaveral	FL	12	009	3,566,630	2,422,595,044	0.00147	5,701,233	8,394	25%	2,098
Port Dolomite	MI	26	097	3,318,441	2,422,595,044	0.00137	5,701,233	7,809	25%	1,952
Port Everglades	FL	12	011	18,896,571	2,422,595,044	0.00780	5,701,233	44,470	25%	11,118
Port Inland	MI	26	153	5,062,723	2,422,595,044	0.00209	5,701,233	11,914	25%	2,979
Port Jefferson	NY	36	103	2,988,115	2,422,595,044	0.00123	5,701,233	7,032	25%	1,758
Portland	ME	23	005	15,242,802	2,422,595,044	0.00629	5,701,233	35,872	25%	8,968
Portland	OR	41	051	29,733,913	2,422,595,044	0.01227	5,701,233	69,975	25%	17,494
Portsmouth	NH	33	015	3,708,169	2,422,595,044	0.00153	5,701,233	8,727	25%	2,182
Presque Isle	MI	26	141	8,958,976	2,422,595,044	0.00370	5,701,233	21,084	25%	5,271
Providence	RI	44	007	7,802,779	2,422,595,044	0.00322	5,701,233	18,363	25%	4,591
Redwood City	CA	06	081	985,392	2,422,595,044	0.00041	5,701,233	2,319	25%	580
Richmond	CA	06	013	21,802,748	2,422,595,044	0.00900	5,701,233	51,310	25%	12,827
Richmond	VA	51	760	1,499,218	2,422,595,044	0.00062	5,701,233	3,528	25%	882
Sacramento	CA	06	067	1,239,858	2,422,595,044	0.00051	5,701,233	2,918	25%	729
Salem	MA	25	009	1,431,771	2,422,595,044	0.00059	5,701,233	3,369	25%	842
San Diego	CA	06	073	1,842,040	2,422,595,044	0.00076	5,701,233	4,335	25%	1,084
San Francisco	CA	06	075	1,982,145	2,422,595,044	0.00082	5,701,233	4,665	25%	1,166
San Juan	PR	72	127	15,112,223	2,422,595,044	0.00624	5,701,233	35,564	25%	8,891
Sandusky	OH	39	043	3,408,357	2,422,595,044	0.00141	5,701,233	8,021	25%	2,005

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Acet-aldehyde Emission Factor: 2.45E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Benzene Emission Factor: 1.05E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Form-aldehyde Emission Factor: 1.68E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	POM as 7-PAH Emission Factor: 5.81E-09 tons/10 <sup>3</sup> gallon <sup>5</sup>	POM as 16-PAH Emission Factor: 5.88E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Arsenic Emission Factor: 6.58E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Beryllium Emission Factor: 1.40E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Morehead City	NC	37	031	7.99E-03	3.42E-04	5.48E-02	1.89E-05	1.92E-03	2.14E-03	4.56E-05
Mount Vernon	IN	18	129	1.01E-02	4.32E-04	6.90E-02	2.39E-05	2.42E-03	2.70E-03	5.75E-05
Muskegon	MI	26	121	3.13E-03	1.34E-04	2.15E-02	7.42E-06	7.51E-04	8.41E-04	1.79E-05
Nashville	TN	47	037	5.45E-03	2.33E-04	3.73E-02	1.29E-05	1.31E-03	1.46E-03	3.11E-05
Nawiliwili, Kauai	HI	15	007	1.73E-03	7.43E-05	1.19E-02	4.11E-06	4.16E-04	4.66E-04	9.91E-06
New Castle	DE	10	003	1.35E-02	5.79E-04	9.27E-02	3.21E-05	3.24E-03	3.63E-03	7.72E-05
New Haven	CT	09	009	1.27E-02	5.46E-04	8.74E-02	3.02E-05	3.06E-03	3.42E-03	7.28E-05
New Orleans	LA	22	071	1.21E-01	5.17E-03	8.28E-01	2.86E-04	2.90E-02	3.24E-02	6.90E-04
New York	NY	36	065	1.90E-01	8.13E-03	1.30E+00	4.50E-04	4.55E-02	5.09E-02	1.08E-03
Newport News	VA	51	700	3.57E-02	1.53E-03	2.45E-01	8.47E-05	8.57E-03	9.60E-03	2.04E-04
Nikishka	AK	02	290	7.28E-03	3.12E-04	4.99E-02	1.73E-05	1.75E-03	1.95E-03	4.16E-05
Norfolk Harbor	VA	51	710	7.10E-02	3.04E-03	4.87E-01	1.68E-04	1.70E-02	1.91E-02	4.06E-04
Oakland	CA	06	001	1.62E-02	6.94E-04	1.11E-01	3.84E-05	3.88E-03	4.35E-03	9.25E-05
Olympia	WA	53	067	2.73E-03	1.17E-04	1.87E-02	6.47E-06	6.55E-04	7.33E-04	1.56E-05
Palm Beach	FL	12	099	3.31E-03	1.42E-04	2.27E-02	7.84E-06	7.93E-04	8.88E-04	1.89E-05
Panama City	FL	12	005	4.50E-03	1.93E-04	3.09E-02	1.07E-05	1.08E-03	1.21E-03	2.57E-05
Pascagoula	MS	28	059	4.23E-02	1.81E-03	2.90E-01	1.00E-04	1.02E-02	1.14E-02	2.42E-04
Paulsboro	NJ	34	015	3.61E-02	1.55E-03	2.47E-01	8.56E-05	8.66E-03	9.69E-03	2.06E-04
Pensacola	FL	12	033	1.99E-03	8.52E-05	1.36E-02	4.71E-06	4.77E-04	5.34E-04	1.14E-05
Philadelphia	PA	42	101	6.04E-02	2.59E-03	4.14E-01	1.43E-04	1.45E-02	1.62E-02	3.45E-04
Pittsburgh	PA	42	003	7.33E-02	3.14E-03	5.03E-01	1.74E-04	1.76E-02	1.97E-02	4.19E-04
Plaquemines, Port of	LA	22	047	9.64E-02	4.13E-03	6.61E-01	2.29E-04	2.31E-02	2.59E-02	5.51E-04
Port Angeles	WA	53	009	4.01E-03	1.72E-04	2.75E-02	9.50E-06	9.62E-04	1.08E-03	2.29E-05
Port Arthur	TX	48	245	5.36E-02	2.30E-03	3.67E-01	1.27E-04	1.29E-02	1.44E-02	3.06E-04
Port Canaveral	FL	12	009	5.14E-03	2.20E-04	3.53E-02	1.22E-05	1.23E-03	1.38E-03	2.94E-05
Port Dolomite	MI	26	097	4.78E-03	2.05E-04	3.28E-02	1.13E-05	1.15E-03	1.28E-03	2.73E-05
Port Everglades	FL	12	011	2.72E-02	1.17E-03	1.87E-01	6.46E-05	6.54E-03	7.32E-03	1.56E-04
Port Inland	MI	26	153	7.30E-03	3.13E-04	5.00E-02	1.73E-05	1.75E-03	1.96E-03	4.17E-05
Port Jefferson	NY	36	103	4.31E-03	1.85E-04	2.95E-02	1.02E-05	1.03E-03	1.16E-03	2.46E-05
Portland	ME	23	005	2.20E-02	9.42E-04	1.51E-01	5.21E-05	5.27E-03	5.90E-03	1.26E-04
Portland	OR	41	051	4.29E-02	1.84E-03	2.94E-01	1.02E-04	1.03E-02	1.15E-02	2.45E-04
Portsmouth	NH	33	015	5.35E-03	2.29E-04	3.67E-02	1.27E-05	1.28E-03	1.44E-03	3.05E-05
Presque Isle	MI	26	141	1.29E-02	5.53E-04	8.86E-02	3.06E-05	3.10E-03	3.47E-03	7.38E-05
Providence	RI	44	007	1.12E-02	4.82E-04	7.71E-02	2.67E-05	2.70E-03	3.02E-03	6.43E-05
Redwood City	CA	06	081	1.42E-03	6.09E-05	9.74E-03	3.37E-06	3.41E-04	3.81E-04	8.12E-06
Richmond	CA	06	013	3.14E-02	1.35E-03	2.16E-01	7.45E-05	7.54E-03	8.44E-03	1.80E-04
Richmond	VA	51	760	2.16E-03	9.26E-05	1.48E-02	5.12E-06	5.19E-04	5.80E-04	1.23E-05
Sacramento	CA	06	067	1.79E-03	7.66E-05	1.23E-02	4.24E-06	4.29E-04	4.80E-04	1.02E-05
Salem	MA	25	009	2.06E-03	8.84E-05	1.42E-02	4.89E-06	4.95E-04	5.54E-04	1.18E-05
San Diego	CA	06	073	2.66E-03	1.14E-04	1.82E-02	6.30E-06	6.37E-04	7.13E-04	1.52E-05
San Francisco	CA	06	075	2.86E-03	1.22E-04	1.96E-02	6.78E-06	6.86E-04	7.67E-04	1.63E-05
San Juan	PR	72	127	2.18E-02	9.34E-04	1.49E-01	5.17E-05	5.23E-03	5.85E-03	1.24E-04
Sandusky	OH	39	043	4.91E-03	2.11E-04	3.37E-02	1.17E-05	1.18E-03	1.32E-03	2.81E-05

## **APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS**

## **Method:**

Port Residual Fuel Oil Emissions (Continued)											
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Cadmium Emission Factor: 1.96E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Chromium Emission Factor: 4.20E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Lead Emission Factor: 7.70E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Manganese Emission Factor: 1.47E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Mercury Emission Factor: 5.67E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Nickel Emission Factor: 4.20E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Selenium Emission Factor: 3.43E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	
Morehead City	NC	37	031	6.39E-04	1.37E-03	2.51E-03	4.79E-03	1.85E-04	1.37E-01	1.12E-03	
Mount Vernon	IN	18	129	8.06E-04	1.73E-03	3.16E-03	6.04E-03	2.33E-04	1.73E-01	1.41E-03	
Muskegon	MI	26	121	2.50E-04	5.37E-04	9.84E-04	1.88E-03	7.25E-05	5.37E-02	4.38E-04	
Nashville	TN	47	037	4.36E-04	9.34E-04	1.71E-03	3.27E-03	1.26E-04	9.34E-02	7.62E-04	
Nawiliwili, Kauai	HI	15	007	1.39E-04	2.97E-04	5.45E-04	1.04E-03	4.01E-05	2.97E-02	2.43E-04	
New Castle	DE	10	003	1.08E-03	2.32E-03	4.25E-03	8.11E-03	3.13E-04	2.32E-01	1.89E-03	
New Haven	CT	09	009	1.02E-03	2.18E-03	4.00E-03	7.64E-03	2.95E-04	2.18E-01	1.78E-03	
New Orleans	LA	22	071	9.65E-03	2.07E-02	3.79E-02	7.24E-02	2.79E-03	2.07E+00	1.69E-02	
New York	NY	36	065	1.52E-02	3.25E-02	5.96E-02	1.14E-01	4.39E-03	3.25E+00	2.66E-02	
Newport News	VA	51	700	2.86E-03	6.12E-03	1.12E-02	2.14E-02	8.27E-04	6.12E-01	5.00E-03	
Nikishka	AK	02	290	5.82E-04	1.25E-03	2.29E-03	4.37E-03	1.68E-04	1.25E-01	1.02E-03	
Norfolk Harbor	VA	51	710	5.68E-03	1.22E-02	2.23E-02	4.26E-02	1.64E-03	1.22E+00	9.94E-03	
Oakland	CA	06	001	1.29E-03	2.77E-03	5.09E-03	9.71E-03	3.75E-04	2.77E-01	2.27E-03	
Olympia	WA	53	067	2.18E-04	4.68E-04	8.58E-04	1.64E-03	6.31E-05	4.68E-02	3.82E-04	
Palm Beach	FL	12	099	2.64E-04	5.67E-04	1.04E-03	1.98E-03	7.65E-05	5.67E-02	4.63E-04	
Panama City	FL	12	005	3.60E-04	7.72E-04	1.42E-03	2.70E-03	1.04E-04	7.72E-02	6.30E-04	
Pascagoula	MS	28	059	3.38E-03	7.25E-03	1.33E-02	2.54E-02	9.79E-04	7.25E-01	5.92E-03	
Paulsboro	NJ	34	015	2.89E-03	6.19E-03	1.13E-02	2.17E-02	8.35E-04	6.19E-01	5.05E-03	
Pensacola	FL	12	033	1.59E-04	3.41E-04	6.25E-04	1.19E-03	4.60E-05	3.41E-02	2.78E-04	
Philadelphia	PA	42	101	4.83E-03	1.03E-02	1.90E-02	3.62E-02	1.40E-03	1.03E+00	8.45E-03	
Pittsburgh	PA	42	003	5.87E-03	1.26E-02	2.30E-02	4.40E-02	1.70E-03	1.26E+00	1.03E-02	
Plaquemines, Port of	LA	22	047	7.72E-03	1.65E-02	3.03E-02	5.79E-02	2.23E-03	1.65E+00	1.35E-02	
Port Angeles	WA	53	009	3.21E-04	6.87E-04	1.26E-03	2.40E-03	9.27E-05	6.87E-02	5.61E-04	
Port Arthur	TX	48	245	4.28E-03	9.18E-03	1.68E-02	3.21E-02	1.24E-03	9.18E-01	7.50E-03	
Port Canaveral	FL	12	009	4.11E-04	8.81E-04	1.62E-03	3.08E-03	1.19E-04	8.81E-02	7.20E-04	
Port Dolomite	MI	26	097	3.83E-04	8.20E-04	1.50E-03	2.87E-03	1.11E-04	8.20E-02	6.70E-04	
Port Everglades	FL	12	011	2.18E-03	4.67E-03	8.56E-03	1.63E-02	6.30E-04	4.67E-01	3.81E-03	
Port Inland	MI	26	153	5.84E-04	1.25E-03	2.29E-03	4.38E-03	1.69E-04	1.25E-01	1.02E-03	
Port Jefferson	NY	36	103	3.45E-04	7.38E-04	1.35E-03	2.58E-03	9.97E-05	7.38E-02	6.03E-04	
Portland	ME	23	005	1.76E-03	3.77E-03	6.91E-03	1.32E-02	5.08E-04	3.77E-01	3.08E-03	
Portland	OR	41	051	3.43E-03	7.35E-03	1.35E-02	2.57E-02	9.92E-04	7.35E-01	6.00E-03	
Portsmouth	NH	33	015	4.28E-04	9.16E-04	1.68E-03	3.21E-03	1.24E-04	9.16E-02	7.48E-04	
Presque Isle	MI	26	141	1.03E-03	2.21E-03	4.06E-03	7.75E-03	2.99E-04	2.21E-01	1.81E-03	
Providence	RI	44	007	9.00E-04	1.93E-03	3.53E-03	6.75E-03	2.60E-04	1.93E-01	1.57E-03	
Redwood City	CA	06	081	1.14E-04	2.43E-04	4.46E-04	8.52E-04	3.29E-05	2.43E-02	1.99E-04	
Richmond	CA	06	013	2.51E-03	5.39E-03	9.88E-03	1.89E-02	7.27E-04	5.39E-01	4.40E-03	
Richmond	VA	51	760	1.73E-04	3.70E-04	6.79E-04	1.30E-03	5.00E-05	3.70E-02	3.03E-04	
Sacramento	CA	06	067	1.43E-04	3.06E-04	5.62E-04	1.07E-03	4.14E-05	3.06E-02	2.50E-04	
Salem	MA	25	009	1.65E-04	3.54E-04	6.49E-04	1.24E-03	4.78E-05	3.54E-02	2.89E-04	
San Diego	CA	06	073	2.12E-04	4.55E-04	8.34E-04	1.59E-03	6.14E-05	4.55E-02	3.72E-04	
San Francisco	CA	06	075	2.29E-04	4.90E-04	8.98E-04	1.71E-03	6.61E-05	4.90E-02	4.00E-04	
San Juan	PR	72	127	1.74E-03	3.73E-03	6.85E-03	1.31E-02	5.04E-04	3.73E-01	3.05E-03	
Sandusky	OH	39	043	3.93E-04	8.42E-04	1.54E-03	2.95E-03	1.14E-04	8.42E-02	6.88E-04	

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Local Port Traffic (short tons) <sup>1</sup>	National Total Port Traffic (short tons) <sup>1</sup>	% Total Traffic by Port	Nat'l Residual Oil Sales (10 <sup>3</sup> gallons) <sup>2</sup>	Local Port Resid. Oil Sales (10 <sup>3</sup> gallons)	25% Resid. Oil Used In Port <sup>3</sup>	Total Resid. Oil Used in Port (10 <sup>3</sup> gallons)
Savannah	GA	13	051	17,598,389	2,422,595,044	0.00726	5,701,233	41,415	25%	10,354
Searsport	ME	23	027	1,432,945	2,422,595,044	0.00059	5,701,233	3,372	25%	843
Seattle	WA	53	033	23,546,789	2,422,595,044	0.00972	5,701,233	55,414	25%	13,854
Silver Bay	MN	27	075	5,240,398	2,422,595,044	0.00216	5,701,233	12,333	25%	3,083
South Louisiana, Port of	LA	22	009	189,814,564	2,422,595,044	0.07835	5,701,233	446,702	25%	111,675
St. Clair	MI	26	099	5,426,565	2,422,595,044	0.00224	5,701,233	12,771	25%	3,193
St. Louis	MO	29	510	30,161,905	2,422,595,044	0.01245	5,701,233	70,982	25%	17,745
St. Paul	MN	27	163	4,755,765	2,422,595,044	0.00196	5,701,233	11,192	25%	2,798
Stamford	CT	09	001	1,036,791	2,422,595,044	0.00043	5,701,233	2,440	25%	610
Stockton	CA	06	077	1,142,608	2,422,595,044	0.00047	5,701,233	2,689	25%	672
Stoneport	MI	26	141	7,989,550	2,422,595,044	0.00330	5,701,233	18,802	25%	4,701
Tacoma	WA	53	053	21,490,783	2,422,595,044	0.00887	5,701,233	50,576	25%	12,644
Taconite	MN	27	061	8,408,145	2,422,595,044	0.00347	5,701,233	19,787	25%	4,947
Tampa	FL	12	057	49,292,651	2,422,595,044	0.02035	5,701,233	116,003	25%	29,001
Texas City	TX	48	167	56,393,758	2,422,595,044	0.02328	5,701,233	132,715	25%	33,179
Toledo	OH	39	095	13,031,631	2,422,595,044	0.00538	5,701,233	30,668	25%	7,667
Tulsa, Port of Catoosa	OK	40	143	1,909,574	2,422,595,044	0.00079	5,701,233	4,494	25%	1,123
Two Harbors	MN	27	075	10,661,655	2,422,595,044	0.00440	5,701,233	25,091	25%	6,273
Valdez	AK	02	261	77,116,459	2,422,595,044	0.03183	5,701,233	181,483	25%	45,371
Vancouver	WA	53	011	7,703,713	2,422,595,044	0.00318	5,701,233	18,130	25%	4,532
Vicksburg	MS	28	149	4,728,437	2,422,595,044	0.00195	5,701,233	11,128	25%	2,782
Victoria	TX	48	469	4,351,045	2,422,595,044	0.00180	5,701,233	10,240	25%	2,560
Weedon Island	FL	12	103	1,300,587	2,422,595,044	0.00054	5,701,233	3,061	25%	765
Wilmington	DE	10	003	4,323,864	2,422,595,044	0.00178	5,701,233	10,176	25%	2,544
Wilmington	NC	37	129	7,581,853	2,422,595,044	0.00313	5,701,233	17,843	25%	4,461

**References**

1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Internet: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.

2: U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996* . DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.

3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1989.

4: Porter, Fred. Note entitled *Comments on Commercial/Institutional Heating Information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998* , to Anne Pope, U.S. EPA Emission Factor and Inventory Group. U.S. Environmental Protection Agency, Emission Standards Division. Research Triangle Park, NC. November 13, 1998.

5: U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition* , AP-42. Research Triangle Park, NC. 1996.

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)										
Port Name <sup>1</sup>	St.	FIPS State Code	FIPS County Code	Acet-aldehyde Emission Factor: 2.45E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Benzene Emission Factor: 1.05E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Form-aldehyde Emission Factor: 1.68E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	POM as 7-PAH Emission Factor: 5.81E-09 tons/10 <sup>3</sup> gallon <sup>5</sup>	POM as 16-PAH Emission Factor: 5.88E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Arsenic Emission Factor: 6.58E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Beryllium Emission Factor: 1.40E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Savannah	GA	13	051	2.54E-02	1.09E-03	1.74E-01	6.02E-05	6.09E-03	6.81E-03	1.45E-04
Searsport	ME	23	027	2.07E-03	8.85E-05	1.42E-02	4.90E-06	4.96E-04	5.55E-04	1.18E-05
Seattle	WA	53	033	3.39E-02	1.45E-03	2.33E-01	8.05E-05	8.15E-03	9.12E-03	1.94E-04
Silver Bay	MN	27	075	7.55E-03	3.24E-04	5.18E-02	1.79E-05	1.81E-03	2.03E-03	4.32E-05
South Louisiana, Port of	LA	22	009	2.74E-01	1.17E-02	1.88E+00	6.49E-04	6.57E-02	7.35E-02	1.56E-03
St. Clair	MI	26	099	7.82E-03	3.35E-04	5.36E-02	1.85E-05	1.88E-03	2.10E-03	4.47E-05
St. Louis	MO	29	510	4.35E-02	1.86E-03	2.98E-01	1.03E-04	1.04E-02	1.17E-02	2.48E-04
St. Paul	MN	27	163	6.86E-03	2.94E-04	4.70E-02	1.63E-05	1.65E-03	1.84E-03	3.92E-05
Stamford	CT	09	001	1.49E-03	6.40E-05	1.02E-02	3.54E-06	3.59E-04	4.01E-04	8.54E-06
Stockton	CA	06	077	1.65E-03	7.06E-05	1.13E-02	3.91E-06	3.95E-04	4.42E-04	9.41E-06
Stoneport	MI	26	141	1.15E-02	4.94E-04	7.90E-02	2.73E-05	2.76E-03	3.09E-03	6.58E-05
Tacoma	WA	53	053	3.10E-02	1.33E-03	2.12E-01	7.35E-05	7.43E-03	8.32E-03	1.77E-04
Taconite	MN	27	061	1.21E-02	5.19E-04	8.31E-02	2.87E-05	2.91E-03	3.26E-03	6.93E-05
Tampa	FL	12	057	7.11E-02	3.05E-03	4.87E-01	1.68E-04	1.71E-02	1.91E-02	4.06E-04
Texas City	TX	48	167	8.13E-02	3.48E-03	5.57E-01	1.93E-04	1.95E-02	2.18E-02	4.65E-04
Toledo	OH	39	095	1.88E-02	8.05E-04	1.29E-01	4.45E-05	4.51E-03	5.04E-03	1.07E-04
Tulsa, Port of Catoosa	OK	40	143	2.75E-03	1.18E-04	1.89E-02	6.53E-06	6.61E-04	7.39E-04	1.57E-05
Two Harbors	MN	27	075	1.54E-02	6.59E-04	1.05E-01	3.64E-05	3.69E-03	4.13E-03	8.78E-05
Valdez	AK	02	261	1.11E-01	4.76E-03	7.62E-01	2.64E-04	2.67E-02	2.99E-02	6.35E-04
Vancouver	WA	53	011	1.11E-02	4.76E-04	7.61E-02	2.63E-05	2.67E-03	2.98E-03	6.35E-05
Vicksburg	MS	28	149	6.82E-03	2.92E-04	4.67E-02	1.62E-05	1.64E-03	1.83E-03	3.89E-05
Victoria	TX	48	469	6.27E-03	2.69E-04	4.30E-02	1.49E-05	1.51E-03	1.68E-03	3.58E-05
Weedon Island	FL	12	103	1.87E-03	8.03E-05	1.29E-02	4.45E-06	4.50E-04	5.03E-04	1.07E-05
Wilmington	DE	10	003	6.23E-03	2.67E-04	4.27E-02	1.48E-05	1.50E-03	1.67E-03	3.56E-05
Wilmington	NC	37	129	1.09E-02	4.68E-04	7.49E-02	2.59E-05	2.62E-03	2.94E-03	6.24E-05

**References**

- 1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Internet: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.
- 2: U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996* . DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.
- 3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1989.
- 4: Porter, Fred. Note entitled *Comments on Commercial/Institutional Heating Information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998* , to Anne Pope, U.S. EPA Emission Factor and Inventory Group. U.S. Environmental Protection Agency, Emission Standards Division. Research Triangle Park, NC. November 13, 1998.
- 5: U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition* , AP-42. Research Triangle Park, NC. 1996.

## APPENDIX A: 1996 NATIONAL COMMERCIAL MARINE VESSEL EMISSIONS

**Method:**

Port Residual Fuel Oil Emissions (Continued)				Cadmium Emission Factor: 1.96E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Chromium Emission Factor: 4.20E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Lead Emission Factor: 7.70E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Manganese Emission Factor: 1.47E-06 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Mercury Emission Factor: 5.67E-08 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Nickel Emission Factor: 4.20E-05 tons/10 <sup>3</sup> gallon <sup>4,5</sup>	Selenium Emission Factor: 3.43E-07 tons/10 <sup>3</sup> gallon <sup>4,5</sup>
Port Name <sup>1</sup>	St.	FIPs State Code	FIPs County Code							
Savannah	GA	13	051	2.03E-03	4.35E-03	7.97E-03	1.52E-02	5.87E-04	4.35E-01	3.55E-03
Searsport	ME	23	027	1.65E-04	3.54E-04	6.49E-04	1.24E-03	4.78E-05	3.54E-02	2.89E-04
Seattle	WA	53	033	2.72E-03	5.82E-03	1.07E-02	2.04E-02	7.85E-04	5.82E-01	4.75E-03
Silver Bay	MN	27	075	6.04E-04	1.29E-03	2.37E-03	4.53E-03	1.75E-04	1.29E-01	1.06E-03
South Louisiana, Port of	LA	22	009	2.19E-02	4.69E-02	8.60E-02	1.64E-01	6.33E-03	4.69E+00	3.83E-02
St. Clair	MI	26	099	6.26E-04	1.34E-03	2.46E-03	4.69E-03	1.81E-04	1.34E-01	1.10E-03
St. Louis	MO	29	510	3.48E-03	7.45E-03	1.37E-02	2.61E-02	1.01E-03	7.45E-01	6.09E-03
St. Paul	MN	27	163	5.48E-04	1.18E-03	2.15E-03	4.11E-03	1.59E-04	1.18E-01	9.60E-04
Stamford	CT	09	001	1.20E-04	2.56E-04	4.70E-04	8.97E-04	3.46E-05	2.56E-02	2.09E-04
Stockton	CA	06	077	1.32E-04	2.82E-04	5.18E-04	9.88E-04	3.81E-05	2.82E-02	2.31E-04
Stoneport	MI	26	141	9.21E-04	1.97E-03	3.62E-03	6.91E-03	2.67E-04	1.97E-01	1.61E-03
Tacoma	WA	53	053	2.48E-03	5.31E-03	9.74E-03	1.86E-02	7.17E-04	5.31E-01	4.34E-03
Taconite	MN	27	061	9.70E-04	2.08E-03	3.81E-03	7.27E-03	2.80E-04	2.08E-01	1.70E-03
Tampa	FL	12	057	5.68E-03	1.22E-02	2.23E-02	4.26E-02	1.64E-03	1.22E+00	9.95E-03
Texas City	TX	48	167	6.50E-03	1.39E-02	2.55E-02	4.88E-02	1.88E-03	1.39E+00	1.14E-02
Toledo	OH	39	095	1.50E-03	3.22E-03	5.90E-03	1.13E-02	4.35E-04	3.22E-01	2.63E-03
Tulsa, Port of Catoosa	OK	40	143	2.20E-04	4.72E-04	8.65E-04	1.65E-03	6.37E-05	4.72E-02	3.85E-04
Two Harbors	MN	27	075	1.23E-03	2.63E-03	4.83E-03	9.22E-03	3.56E-04	2.63E-01	2.15E-03
Valdez	AK	02	261	8.89E-03	1.91E-02	3.49E-02	6.67E-02	2.57E-03	1.91E+00	1.56E-02
Vancouver	WA	53	011	8.88E-04	1.90E-03	3.49E-03	6.66E-03	2.57E-04	1.90E-01	1.55E-03
Vicksburg	MS	28	149	5.45E-04	1.17E-03	2.14E-03	4.09E-03	1.58E-04	1.17E-01	9.54E-04
Victoria	TX	48	469	5.02E-04	1.08E-03	1.97E-03	3.76E-03	1.45E-04	1.08E-01	8.78E-04
Weedon Island	FL	12	103	1.50E-04	3.21E-04	5.89E-04	1.12E-03	4.34E-05	3.21E-02	2.62E-04
Wilmington	DE	10	003	4.99E-04	1.07E-03	1.96E-03	3.74E-03	1.44E-04	1.07E-01	8.73E-04
Wilmington	NC	37	129	8.74E-04	1.87E-03	3.43E-03	6.56E-03	2.53E-04	1.87E-01	1.53E-03

**References**

- 1: U.S. Army Corps of Engineers. *Waterborne Commerce of the United States, Calendar Year 1996, Part 5 - Waterways and Harbors National Summaries*. Water Resources Support Center. Fort Belvoir, Virginia. Internet: <http://www.wrsc.usace.army.mil/ndc/wcusnatl96.pdf>. March 5, 1999.
- 2: U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996*. DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.
- 3: U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, NC. 1989.
- 4: Porter, Fred. Note entitled *Comments on Commercial/Institutional Heating Information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998*, to Anne Pope, U.S. EPA Emission Factor and Inventory Group. U.S. Environmental Protection Agency, Emission Standards Division. Research Triangle Park, NC. November 13, 1998.
- 5: U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition*, AP-42. Research Triangle Park, NC. 1996.

**Appendix B**

**1996 Locomotive Emission Estimates**

## **APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS**

### **Method:**

#### **Locomotives - 1996 National Emissions**

1996 HAP emissions from locomotives were calculated using the following steps. The calculations can be viewed in the attached spreadsheets.

The 1996 state distillate fuel oil sales (in gallons) for railroad use were obtained from the *Fuel Oil and Kerosene Sales, 1996* report (DOE, 1997). The sales were summed and applied to the individual state sales to calculate the percentage of total sales attributed to each state. These percentages were then applied to the national VOC and PM<sub>10</sub> tons (EPA, 1997) to determine the VOC and PM<sub>10</sub> emissions for each state.

Since locomotives use large diesel/electric engines for propulsion, and locomotive diesel speciation profiles have yet to be developed, the EPA assumed that the speciation profiles for heavy-duty diesel vehicles (HDDV) could also be used for locomotives (EPA, 1992).

The speciation profiles were applied to the tons VOC and PM<sub>10</sub> emissions to estimate the HAP emissions from locomotives. The HDDV speciation profiles were derived from information provided in *Evaluation of Factors That Affect Diesel Exhaust Toxicity* (Truex and Norbeck, 1998). The values given in this reference are in milligrams per brake horsepower-hour (mg/Bhp-hr). An example of how the speciation profiles were derived is as follows:

$$2.14 \text{ acrolein weighted total (mg/Bhp-hr)} / 604.91 \text{ (mg/Bhp-hr)} \text{ VOC weighted total} = \\ 0.0035 \text{ tons acrolein/ tons VOC}$$

The calculations and speciation profiles for locomotives can be found in the attached spreadsheet. Table 1 below displays the speciation profiles used to calculate the locomotive emissions.

**Table 1: Speciation Profiles**

Pollutant	Speciation Profile
Acrolein	0.0035 tons acrolein/VOC
Ethylbenzene	0.0020 tons ethylbenzene/VOC
n-Hexane	0.0055 tons n-hexane/VOC
Propionaldehyde	0.0061 tons propionaldehyde/VOC
Styrene	0.0021 tons styrene/VOC
Toluene	0.0032 tons toluene/VOC
Xylene	0.0048 tons xylene/VOC
Arsenic	3.57E-07 tons arsenic/PM <sub>10</sub>
Chromium	3.27E-06 tons chromium/PM <sub>10</sub>
Manganese	2.04E-06 tons manganese/PM <sub>10</sub>
Nickel	6.55E-06 tons nickel/PM <sub>10</sub>

### **Allocation of State Level HAP Emissions to Counties**

The state-level HAP emissions were then allocated to the county-level based on population statistics.

---

## **APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS**

---

### **Method:**

#### **Locomotives - 1996 National Emissions**

### **References**

Truex, Dr. Timothy J. and Dr. Joseph M. Norbeck. *Evaluation of Factors That Affect Diesel Exhaust Toxicity*. University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996*. DOE/EIA -- 0535 (96), Distribution Category UC-950. Energy Information Administration, Office of Oil and Gas. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.

U.S. Environmental Protection Agency. *Locomotive Emission Standards, Regulatory Support Document*. Office of Mobile Sources. Ann Arbor, MI. April 1997.

U.S. Environmental Protection Agency. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. Office of Mobile Sources, Emission Planning and Strategies Division. Ann Arbor, MI. 1992.

## APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS

### Method:

State	State Distillate Fuel Oil Sales <sup>1</sup>	National Distillate Fuel Oil Use	% Total Sales by State	National Locomotive VOC Emissions (short tons) <sup>2</sup>	State VOC Emissions (short tons)	National Locomotive PM <sub>10</sub> Emissions (short tons)	State PM <sub>10</sub> Emissions (short tons)	Tons Acrolein (0.0035 acrolein/VOC) <sup>3</sup>	Tons Ethylbenzene (0.0020 ethylbenzene/VOC) <sup>3</sup>
AL	52,942,000	3,446,936,000	1.54	48,000	737	27,000	414.70	2.58	1.47
AK	4,495,000	3,446,936,000	0.13	48,000	63	27,000	35.21	0.22	0.13
AZ	3,745,000	3,446,936,000	0.11	48,000	52	27,000	29.33	0.18	0.10
AR	67,559,000	3,446,936,000	1.96	48,000	941	27,000	529.19	3.29	1.88
CA	252,463,000	3,446,936,000	7.32	48,000	3,516	27,000	1,977.55	12.30	7.03
CO	100,324,000	3,446,936,000	2.91	48,000	1,397	27,000	785.84	4.89	2.79
CT	6,338,000	3,446,936,000	0.18	48,000	88	27,000	49.65	0.31	0.18
DE	423,000	3,446,936,000	0.01	48,000	6	27,000	3.31	0.02	0.01
DC	6,283,000	3,446,936,000	0.18	48,000	87	27,000	49.22	0.31	0.17
FL	106,030,000	3,446,936,000	3.08	48,000	1,477	27,000	830.54	5.17	2.95
GA	78,361,000	3,446,936,000	2.27	48,000	1,091	27,000	613.81	3.82	2.18
HI	0	3,446,936,000	0.00	48,000	0	27,000	0.00	0.00	0.00
ID	29,101,000	3,446,936,000	0.84	48,000	405	27,000	227.95	1.42	0.81
IL	204,872,000	3,446,936,000	5.94	48,000	2,853	27,000	1,604.77	9.99	5.71
IN	130,281,000	3,446,936,000	3.78	48,000	1,814	27,000	1,020.50	6.35	3.63
IA	67,532,000	3,446,936,000	1.96	48,000	940	27,000	528.98	3.29	1.88
KS	124,233,000	3,446,936,000	3.60	48,000	1,730	27,000	973.12	6.05	3.46
KY	106,426,000	3,446,936,000	3.09	48,000	1,482	27,000	833.64	5.19	2.96
LA	28,011,000	3,446,936,000	0.81	48,000	390	27,000	219.41	1.37	0.78
ME	5,852,000	3,446,936,000	0.17	48,000	81	27,000	45.84	0.29	0.16
MD	28,932,000	3,446,936,000	0.84	48,000	403	27,000	226.63	1.41	0.81
MA	12,372,000	3,446,936,000	0.36	48,000	172	27,000	96.91	0.60	0.34
MI	44,511,000	3,446,936,000	1.29	48,000	620	27,000	348.66	2.17	1.24
MN	73,042,000	3,446,936,000	2.12	48,000	1,017	27,000	572.14	3.56	2.03
MS	24,897,000	3,446,936,000	0.72	48,000	347	27,000	195.02	1.21	0.69
MO	23,245,000	3,446,936,000	0.67	48,000	324	27,000	182.08	1.13	0.65
MT	71,530,000	3,446,936,000	2.08	48,000	996	27,000	560.30	3.49	1.99
NE	169,069,000	3,446,936,000	4.90	48,000	2,354	27,000	1,324.32	8.24	4.71
NV	8,284,000	3,446,936,000	0.24	48,000	115	27,000	64.89	0.40	0.23
NH	152,000	3,446,936,000	0.00	48,000	2	27,000	1.19	0.01	0.00
NJ	65,054,000	3,446,936,000	1.89	48,000	906	27,000	509.57	3.17	1.81
NM	22,442,000	3,446,936,000	0.65	48,000	313	27,000	175.79	1.09	0.63
NY	7,180,000	3,446,936,000	0.21	48,000	100	27,000	56.24	0.35	0.20
NC	74,266,000	3,446,936,000	2.15	48,000	1,034	27,000	581.73	3.62	2.07
ND	47,410,000	3,446,936,000	1.38	48,000	660	27,000	371.36	2.31	1.32
OH	137,926,000	3,446,936,000	4.00	48,000	1,921	27,000	1,080.38	6.72	3.84
OK	155,215,000	3,446,936,000	4.50	48,000	2,161	27,000	1,215.81	7.57	4.32
OR	83,034,000	3,446,936,000	2.41	48,000	1,156	27,000	650.41	4.05	2.31
PA	38,584,000	3,446,936,000	1.12	48,000	537	27,000	302.23	1.88	1.07
RI	97,000	3,446,936,000	0.00	48,000	1	27,000	0.76	0.00	0.00
SC	11,397,000	3,446,936,000	0.33	48,000	159	27,000	89.27	0.56	0.32
SD	1,996,000	3,446,936,000	0.06	48,000	28	27,000	15.63	0.10	0.06
TN	98,703,000	3,446,936,000	2.86	48,000	1,374	27,000	773.14	4.81	2.75
TX	457,357,000	3,446,936,000	13.27	48,000	6,369	27,000	3,582.50	22.29	12.74

## APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS

### Method:

State	Tons n-Hexane (0.0055 n-hexane/VOC) <sup>3</sup>	Tons Propion-aldehyde (0.0061 propion-aldehyde/VOC) <sup>3</sup>	Tons Styrene (0.0021 styrene/VOC) <sup>3</sup>	Tons Toluene (0.0032 toluene/VOC) <sup>3</sup>	Tons Xylene (0.0048 xylene/VOC) <sup>3</sup>	Tons Arsenic (3.57E-07 arsenic/PM 10) <sup>3</sup>	Tons Chromium (3.27E-06 chromium/PM 10) <sup>3</sup>	Tons Manganese (2.04E-06 manganese/PM 10) <sup>3</sup>	Tons Nickel (6.55E-06 nickel/PM 10) <sup>3</sup>
AL	4.05	4.50	1.55	2.36	3.54	1.48E-04	1.36E-03	8.46E-04	2.72E-03
AK	0.34	0.38	0.13	0.20	0.30	1.26E-05	1.15E-04	7.18E-05	2.31E-04
AZ	0.29	0.32	0.11	0.17	0.25	1.05E-05	9.59E-05	5.98E-05	1.92E-04
AR	5.17	5.74	1.98	3.01	4.52	1.89E-04	1.73E-03	1.08E-03	3.47E-03
CA	19.34	21.45	7.38	11.25	16.88	7.06E-04	6.47E-03	4.03E-03	1.30E-02
CO	7.68	8.52	2.93	4.47	6.71	2.81E-04	2.57E-03	1.60E-03	5.15E-03
CT	0.49	0.54	0.19	0.28	0.42	1.77E-05	1.62E-04	1.01E-04	3.25E-04
DE	0.03	0.04	0.01	0.02	0.03	1.18E-06	1.08E-05	6.76E-06	2.17E-05
DC	0.48	0.53	0.18	0.28	0.42	1.76E-05	1.61E-04	1.00E-04	3.22E-04
FL	8.12	9.01	3.10	4.72	7.09	2.97E-04	2.72E-03	1.69E-03	5.44E-03
GA	6.00	6.66	2.29	3.49	5.24	2.19E-04	2.01E-03	1.25E-03	4.02E-03
HI	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ID	2.23	2.47	0.85	1.30	1.95	8.14E-05	7.45E-04	4.65E-04	1.49E-03
IL	15.69	17.40	5.99	9.13	13.69	5.73E-04	5.25E-03	3.27E-03	1.05E-02
IN	9.98	11.07	3.81	5.81	8.71	3.64E-04	3.34E-03	2.08E-03	6.68E-03
IA	5.17	5.74	1.97	3.01	4.51	1.89E-04	1.73E-03	1.08E-03	3.46E-03
KS	9.51	10.55	3.63	5.54	8.30	3.47E-04	3.18E-03	1.99E-03	6.37E-03
KY	8.15	9.04	3.11	4.74	7.11	2.98E-04	2.73E-03	1.70E-03	5.46E-03
LA	2.15	2.38	0.82	1.25	1.87	7.83E-05	7.17E-04	4.48E-04	1.44E-03
ME	0.45	0.50	0.17	0.26	0.39	1.64E-05	1.50E-04	9.35E-05	3.00E-04
MD	2.22	2.46	0.85	1.29	1.93	8.09E-05	7.41E-04	4.62E-04	1.48E-03
MA	0.95	1.05	0.36	0.55	0.83	3.46E-05	3.17E-04	1.98E-04	6.35E-04
MI	3.41	3.78	1.30	1.98	2.98	1.24E-04	1.14E-03	7.11E-04	2.28E-03
MN	5.59	6.20	2.14	3.25	4.88	2.04E-04	1.87E-03	1.17E-03	3.75E-03
MS	1.91	2.11	0.73	1.11	1.66	6.96E-05	6.38E-04	3.98E-04	1.28E-03
MO	1.78	1.97	0.68	1.04	1.55	6.50E-05	5.95E-04	3.71E-04	1.19E-03
MT	5.48	6.08	2.09	3.19	4.78	2.00E-04	1.83E-03	1.14E-03	3.67E-03
NE	12.95	14.36	4.94	7.53	11.30	4.73E-04	4.33E-03	2.70E-03	8.67E-03
NV	0.63	0.70	0.24	0.37	0.55	2.32E-05	2.12E-04	1.32E-04	4.25E-04
NH	0.01	0.01	0.00	0.01	0.01	4.25E-07	3.89E-06	2.43E-06	7.80E-06
NJ	4.98	5.53	1.90	2.90	4.35	1.82E-04	1.67E-03	1.04E-03	3.34E-03
NM	1.72	1.91	0.66	1.00	1.50	6.28E-05	5.75E-04	3.59E-04	1.15E-03
NY	0.55	0.61	0.21	0.32	0.48	2.01E-05	1.84E-04	1.15E-04	3.68E-04
NC	5.69	6.31	2.17	3.31	4.96	2.08E-04	1.90E-03	1.19E-03	3.81E-03
ND	3.63	4.03	1.39	2.11	3.17	1.33E-04	1.21E-03	7.58E-04	2.43E-03
OH	10.56	11.72	4.03	6.15	9.22	3.86E-04	3.53E-03	2.20E-03	7.08E-03
OK	11.89	13.18	4.54	6.92	10.37	4.34E-04	3.98E-03	2.48E-03	7.96E-03
OR	6.36	7.05	2.43	3.70	5.55	2.32E-04	2.13E-03	1.33E-03	4.26E-03
PA	2.96	3.28	1.13	1.72	2.58	1.08E-04	9.88E-04	6.17E-04	1.98E-03
RI	0.01	0.01	0.00	0.00	0.01	2.71E-07	2.48E-06	1.55E-06	4.98E-06
SC	0.87	0.97	0.33	0.51	0.76	3.19E-05	2.92E-04	1.82E-04	5.85E-04
SD	0.15	0.17	0.06	0.09	0.13	5.58E-06	5.11E-05	3.19E-05	1.02E-04
TN	7.56	8.38	2.89	4.40	6.60	2.76E-04	2.53E-03	1.58E-03	5.06E-03
TX	35.03	38.85	13.37	20.38	30.57	1.28E-03	1.17E-02	7.31E-03	2.35E-02

## APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS

### Method:

State	State Distillate Fuel Oil Sales <sup>1</sup>	National Distillate Fuel Oil Use	% Total Sales by State	National Locomotive VOC Emissions (short tons) <sup>2</sup>	State VOC Emissions (short tons)	National Locomotive PM <sub>10</sub> Emissions (short tons) <sup>2</sup>	State PM <sub>10</sub> Emissions (short tons)	Tons Acrolein (0.0035 acrolein/VOC) <sup>3</sup>	Tons Ethylbenzene (0.0020 ethylbenzene/VOC) <sup>3</sup>	
UT	40,899,000	3,446,936,000	1.19	48,000	570	27,000	320.36	1.99	1.14	
VT	542,000	3,446,936,000	0.02	48,000	8	27,000	4.25	0.03	0.02	
VA	131,296,000	3,446,936,000	3.81	48,000	1,828	27,000	1,028.45	6.40	3.66	
WA	75,129,000	3,446,936,000	2.18	48,000	1,046	27,000	588.49	3.66	2.09	
WV	6,458,000	3,446,936,000	0.19	48,000	90	27,000	50.59	0.31	0.18	
WI	56,267,000	3,446,936,000	1.63	48,000	784	27,000	440.74	2.74	1.57	
WY	104,379,000	3,446,936,000	3.03	48,000	1,454	27,000	817.61	5.09	2.91	

### References

- 1: U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996* . DOE/EIA - 0535 (96), Distribution Category UC-950. Energy Information Administration, Office of Oil and Gas. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.
- 2: U.S. Environmental Protection Agency. *Locomotive Emission Standards, Regulatory Support Document* . Office of Mobile Sources. Ann Arbor, MI. April 1997.
- 3: Truex, Dr. Timothy and Dr. Joseph M. Norbeck. *Evaluation Factors That Affect Diesel Exhaust Toxicity* . University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA.. March 16, 1998.

## APPENDIX B: 1996 NATIONAL LOCOMOTIVE EMISSIONS

### Method:

State	Tons n-Hexane (0.0055 n-hexane/ VOC) <sup>3</sup>	Tons Propion-aldehyde (0.0061 propion-aldehyde/ VOC) <sup>3</sup>	Tons Styrene (0.0021 styrene/ VOC) <sup>3</sup>	Tons Toluene (0.0032 toluene/ VOC) <sup>3</sup>	Tons Xylene (0.0048 xylene/ VOC) <sup>3</sup>	Tons Arsenic (3.57E-07 arsenic/ PM 10) <sup>3</sup>	Tons Chromium (3.27E-06 chromium/ PM 10) <sup>3</sup>	Tons Manganese (2.04E-06 manganese/ PM 10) <sup>3</sup>	Tons Nickel (6.55E-06 nickel/ PM 10) <sup>3</sup>
UT	3.13	3.47	1.20	1.82	2.73	1.14E-04	1.05E-03	6.54E-04	2.10E-03
VT	0.04	0.05	0.02	0.02	0.04	1.52E-06	1.39E-05	8.66E-06	2.78E-05
VA	10.06	11.15	3.84	5.85	8.78	3.67E-04	3.36E-03	2.10E-03	6.74E-03
WA	5.75	6.38	2.20	3.35	5.02	2.10E-04	1.92E-03	1.20E-03	3.85E-03
WV	0.49	0.55	0.19	0.29	0.43	1.81E-05	1.65E-04	1.03E-04	3.31E-04
WI	4.31	4.78	1.65	2.51	3.76	1.57E-04	1.44E-03	8.99E-04	2.89E-03
WY	7.99	8.87	3.05	4.65	6.98	2.92E-04	2.67E-03	1.67E-03	5.36E-03

### References

- 1: U.S. Department of Energy. *Fuel Oil and Kerosene Sales, 1996* . DOE/EIA - 0535 (96), Distribution Category UC-950. Energy Information Administration, Office of Oil and Gas. Washington, DC. Available at the following Internet site: [http://www.eia.doe.gov/oil\\_gas/petroleum/pet\\_frame.html](http://www.eia.doe.gov/oil_gas/petroleum/pet_frame.html). August 1997.
- 2: U.S. Environmental Protection Agency. Locomotive Emission Standards, Regulatory Support Document. Office of Mobile Sources. Ann Arbor, MI. April 1997.
- 3: Truex, Dr. Timothy and Dr. Joseph M. Norbeck. *Evaluation Factors That Affect Diesel Exhaust Toxicity* . University of California-Riverside, Center for Environmental Research and Technology. Riverside, CA. March 16, 1998.

## **Appendix C**

### **Selected References for CMV Estimates**

**Date:** 2/24/99 10:56 AM  
**Sender:** RICH COOK <COOK.RICH@epamail.epa.gov>  
**To:** teresa kraus  
**cc:** JANSSEN.GREG@epamail.epa.gov; SAMULSKI.MICHAEL@epamail.epa.gov; WILCOX.RICH@epamail.epa.gov; richard billings  
**Priority:** Normal  
**Subject:** Marine Vessel Methodology Reference -Reply

---

Author: RICH COOK <COOK.RICH@epamail.epa.gov> at Internet

Date: 2/24/99 10:56:00 AM

Priority: Normal

To: teresa kraus at ~MOR\_P001

cc: JANSSEN.GREG@epamail.epa.gov at INTERNET

cc: SAMULSKI.MICHAEL@epamail.epa.gov at INTERNET

cc: WILCOX.RICH@epamail.epa.gov at INTERNET

cc: richard billings at ~MOR\_P001

Subject: Marine Vessel Methodology Reference -Reply

Below is the e-mail I sent a little while back. I'll have to leave this one up to your professional judgement. Seems like what you are proposing for marine vessels using residual oil might be more reasonable than what I suggested in my e-mail. I'll copy some folks here with expertise in this area. They can respond if they have any thoughts on this.

>>>>>>;a>>>>>

2/2/99 e-mail --

For this category we should assume in-port operations represent urban emissions, and out of port operations represent rural.

I talked to Jim Corbett of Carnegie-Mellon University, who has looked at in port versus out of port operations. He recommended we assume 10% of commercial marine vessel operations are in port. This estimate comes from a Finnish study. I will send you a reference to cite. He feels this is a defensible number, the real number might be a little lower, but it would be hard to argue it should be higher.

He also said 2% of US waterway miles are in port, but there is hoteling, anchoring etc in port that would make 2% an underestimate. He suggested a couple studies that could be used to get a better estimate (an Acurex study for California and a Boston Harbor Port inventory done by Nescaum) but I don't think this would be worth spending time and money on.

One other point. I suggested in our call using nonroad diesel speciation profiles to come up with toxic emission estimates. Corbett pointed out commercial marine diesels use a residual fuel, higher in sulfur and other heavy metals, but lower in volatiles. Corbett said using the nonroad diesel speciation is a reasonable approximation, but we should perhaps point out that fuel differences introduce uncertainty into the assumption that the toxic fractions used for nonroad diesels are very similar to commercial marine.

>>> <tkraus@erg.com> 02/23/99 02:57pm >>>

Rich,

For the 1990 marine vessel emissions, we are applying HDDV speciation profiles to the VOC emissions from marine vessels using distillate fuel oil. We are using the emission factors applicable to residual oil combustion for marine vessels using residual fuel oil. Richard and I thought that you said this would be okay, but neither of us has any documentation confirming this. If you could reply to this **e-mail** letting me know if this is okay, I would appreciate it (I need your confirmation for referencing purposes). Thanks.

Teresa



Teresa Kraus  
Eastern Research Group, Inc.  
1600 Perimeter Park  
Morrisville, NC 27560  
[tkraus@erg.com](mailto:tkraus@erg.com)  
(919) 468-7854

RFC822.TXT

<b>Nationwide Emissions from Commercial/Institutional Heating for Residual Oil Combustion, 1992</b>				
Pollutant	Emission Factor (lb/MM Btu Oil)	Emission Factor Reference	National Activity Level (Reference 1) (MM Btu oil burned/year)	National Emissions (tons/year)
acetaldehyde	3.5E-05	Reference 2	3.75E+08	6.56E+00
benzene	1.5E-06	Reference 2, 3	3.75E+08	2.81 E-01
formaldehyde	2.4E-04	Reference 2, 3	3.75E+08	4.50E+01
POM as 16-PAH	8.4E-06	Reference 2, 3	3.75E+08	1.58E+00

References:

- U.S. Environmental Protection Agency. 1990 Inventory of Section 112(c)6 Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), Polychlorinated Biphenyl Compounds (PCBs), Hexachlorobenzene, Mercury, and Alkylated Lead. Final Report. Research Triangle Park, North Carolina. June 1997.
- Porter, Fred, U.S. Environmental Protection Agency, Emission Standards Division. Note to Anne Pope, US. EPA/Emissions Monitoring and Analysis Division. Comments on Commercial/Institutional Heating information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources -- Interim Final Report," September 18, 1998. November 13, 1998.
- U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42. Volume I: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1996.

Nationwide Emissions from Commercial/Institutional Heating for Residual Oil Combustion, 1992				
Pollutant	Emission Factor (lb/MM Btu Oil)	Emission Factor Reference	National Activity Level (Reference 1) (MM Btu oil burned/year)	National Emissions (tons/year)
arsenic	9.4E-06	Reference 2, 3	3.75E+08	1.76E+00
beryllium	2.0E-07	Reference 2, 3	3.75E+08	3.75E-02
cadmium	2.8E-06	Reference 2, 3	3.75E+08	5.25E-01
chromium	6.0E-06	Reference 2, 3	3.75E+08	1.13E+00
lead	1.1 E-05	Reference 2, 3	3.75E+08	2.06E+00
manganese	2.1 E-05	Reference 2, 3	3.75E+08	3.94E+00
mercury	8.1 E-07	Reference 2, 3	3.75E+08	1.52E-01
nickel	6.0E-04	Reference 2, 3	3.75E+08	1.13E+02
selenium	4.9E-06	Reference 2, 3	3.75E+08	9.19E-01

References:

1. U.S. Environmental Protection Agency. 1990 Inventory of Section 112(c)6 Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzo-furan (TCDF), Polychlorinated Biphenyl Compounds (PCBs), Hexachlorobenzene, Mercury, and Alkylated Lead. Final Report. Research Triangle Park, North Carolina. June 1997.
2. Porter, Fred, U.S. Environmental Protection Agency, Emission Standards Division. Note to Anne Pope, U.S. EPA/Emissions Monitoring and Analysis Division. Comments on Commercial/Institutional Heating information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources -- Interim Final Report," September 18, 1998. November 13, 1998.
3. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42, Volume I: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1996.